that is of modern origin and highly efficient, and they can produce foods with the quality and reliability needed to meet the standards of industrialized nations. In general, however, the price of food products distributed within Singapore is low and there is a limitation to the ability to invest in improvement of quality, making the products to be somewhat insufficient as internationally traded goods.

(3) Cost structure

The cost of material inputs for food production is 68.6%, and it is 48.7% in the beverages industry. There was a ratio exceeding 75% in the food products industry from 1981 to 1986 but it has declined since then.

The cost of material inputs for beverage production has been about 50%. The shares of packaging is high in some food product categories such as soy sauce (47.9%), canned meat (36.1%), biscuits (32.3%), snack confections (28.1%) and condensed milk (20.5%).

(4) Distribution structure

Retail distribution channels for foods and beverages in Singapore comprise variety stores, and supermarkets and department stores. Although the number of supermarkets and department stores is only 1/27 of that of the variety stores[7], in terms of the number of employees that are 1.2 times greater, in terms of sales they are 2.1 times greater, and in terms of value added that are 4.2 times greater. It is expected that the number of supermarkets and department stores will continued to increase in the future.

3.2.3 Current Situation and Problems of Packaging

3.2.3.1 Packaging in the food industry

(1) The role of food packaging

Food packaging includes primary packaging carried out chiefly to preserve the items packaged and secondary packaging mainly for the purposes of transportation of products. Together these two types of packaging constitute the overall role of packaging in the processing and distribution stages. Foodstuffs vary widely in terms of varieties and characteristics and the conditions for the processing and distribution of individual food items differ by item so that the exact functional demands required to be met by packaging also differ. Consequently food packaging is extremely diversified.

The main functions required of food packaging are as follows;

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[7] Ministry of Trade and Industry, "Economic Surveys Series – Wholesale and retail 1990."

1) preservation of contents
2) marketability
3) appropriateness to processing treatment
4) protection of contents
5) appropriateness for end uses
6) disposability
7) economical viability

Of the above functions preservation of contents, appropriateness to processing treatment and appropriateness for end uses are particularly emphasized.

The above functions are required to realize the maintenance of product quality in view of product conditions envisaged at the time of use or consumption. For example, in the case of electronic devices or other hardware products it is possible to display sample products taken out of packages in retail stores for consumers to operate and try out. Moreover the functioning of the items displayed will show almost no deterioration as a result of short term display or a limited number of trial operations. In some cases customers will even ask to have the product they intend to buy taken out of its packaging for trial operation before having this repackaged to take home with them.

However, the majority of foodstuffs are displayed in retail stores in packaged form, and except in special cases where product tasting before purchase is possible, the quality of the contents in terms of taste can not be examined. Obviously it is not possible for a customer to try out the taste of items and decide on purchase as a result, returning products which are found unappetizing. The use stage of consumption in the case of foodstuffs entails the actual consumption (destruction) of the product itself so that a trial examination necessarily involves the destruction of the product.

Another characteristic of food items is the fact that the value of the packaged contents are not of a high value nature. Even if a certain number of commodities are damaged during transportation this will not represent a large loss, and it will be easy to have the damaged items replaced. Therefore, there are limits to the costs which can be accorded to packaging. In particular, in the case of countries where production costs of agricultural products are low the packaging costs are frequently found to outweigh the cost of the food items themselves. In such circumstances it often becomes necessary to limit the performance of food packaging in line with the limits imposed by the cost burdens of packaging.

In Japan the ratio of the delivery cost accounted for by packaging costs are on average between 5 and 10%, so that the mean average is about 8%. Generally speaking such packaging costs are low in the case of agricultural products and tend to be higher in the case of processed foodstuffs, particularly for those which are of a single service size. Further packaging costs are even higher for gift wrapped items reaching a level superior to 30% of delivery costs for items such as fruit baskets or dried food items.

Each of these main functions for food packaging is as follows.

1) Preservation of contents

A major difference between conditions of packaging for foodstuffs in contrast with other types of packaging is the importance of shelf life (the period during which food is acceptable). Normally there is no decline in the enveloping performance of packages so that the main task met by packaging is to ensure the transport of items from the place of production (packaging) to the place of consumption (use). However product deterioration of foodstuffs is considerably faster compared to that of machinery or devices, pharmaceutical products, chemicals, etc. and so in order to prevent the occurrence of such problems it is necessary to carry out a variety of processing treatments on packaging for foodstuffs over and above what is required for packaging of other commodities.

In this way the quality of processed foodstuffs after processing is preserved and packaging must be used effectively to ensure that the food items satisfy the hunger, provide nutrition and please the taste of consumers. It is therefore possible to assert that the development of packaging has progressed in conjunction with the history of food processing since the two aspects are inextricably linked.

2) Marketability

Packaging also plays an important role in the marketing of foodstuffs. The decision to purchase is an extremely important stage in marketing. The decision to purchase is strongly influenced by the appeal exercised by packaging and the different varieties of information conveyed by the packaging itself in the case of food items.

Food items are often displayed for sale in retail stores with only primary packaging. In particular such a sales trend is very strong for processed foods in self service stores such as supermarkets. In such cases customers are often unable to see the actual food item, and so they must decide on a purchase on the basis of information provided on packaging as to the nature of the contents. When purchasing the same product on future

occasions the customers also rely on packaging information to confirm that the product is the similar item previously purchased.

Further, since the items purchased will be used in cooking in the home before being eaten there is often a considerable difference in the form and appearance of foodstuffs at the time of purchase and at the time of final consumption. In such cases photographs or other representations of the product on packaging will show the item in its form for serving suggestion and so in cooked form rather than as it will appear when taken out of the packaging.

The appeal exercised by packaging on customers is especially important in the case of newly marketed or launched products. Only rarely does purchase follow upon an actual trial consumption prior to purchase of the food item itself. Rather it is usual for consumers to construct a personal image of the product in question on the basis of information received from a variety of sources such as advertising, packaging, etc. When the image seems to promise satisfaction a decision to purchase is then made.

On the other hand, inappropriate packaging can result in a decision not to purchase. This is not generally the case with other types of product. However it frequently occurs with food items, when the packaging exceeds that required for simple protection of the product, and the quality of the packaging material used is inferior to expectations then it will be judged inappropriate by consumers who will then decide not to purchase. However such evaluative decisions are not the result of economic considerations alone but involve a variety of social and cultural factors in complex interaction, and so they are often very difficult to comprehend for observers who do not share or appreciate the social and cultural codes of reference underlying such value judgments.

The major conditions relating to the marketing functions of food packaging are as follows;

a) visual recognizability (making it easy to recognize a particular commodity by color, graphic design, texture, etc.)
b) package recognizability (making it easy to recognize a particular commodity by the package shape, dimensions,etc.)
c) content appeal (explanation of the special characteristics of the contents)
d) ease of handling and display in retail stores

3) Appropriateness to processing Treatment

Packaging machinery is used to insert processed foodstuffs in special vessels, containers or packaging envelopes. It is necessary for the packaging container or envelope in such cases to a) be compatible with the packaging machinery to be used, b)

allow for easy operations at the time of insertion and c) retain appropriate sealing conditions after insertion of contents and d) be compatible with secondary packaging operations and machinery in cases where this takes place. Further goods packaged in cans and pouch packed foods also undergo heat treatment, so that the packaging containers used need to have heat resistance, ease of handling and compatibility with cooking devices, etc. Since provision of the above characteristics results in a loss of some of the functional characteristics demanded of packaging by consumers and distributors such packaging demands a functional profile containing characteristics which are contradictory.

4) Protection of contents

As in the case of packaging for electrical goods the packaging is required to provide a protective function to ensure that physical damage to goods is avoided during distribution stages.

Although this is the main functional aspect of secondary packaging, primary packaging also carries out this role in the case of cartons or hard packaging containers. In particular, the protective role of primary packaging is also important in the case of food items where physical damage can easily occur during display arranging in retail stores or during purchasing by customers.

5) Appropriateness for end uses

Food items are ultimately to be removed from their packaging envelopes or containers in order to be consumed but a number of stages are involved from time of purchase up to point of consumption. These include storage on kitchen or refrigerator shelves, opening of packaging, disposal or destruction of packaging, and removal of contents. Finally for many food items the primary package also serves as a dispenser or food container right up to the final stages of use. A variety of functions may be demanded depending on the final circumstances of use and the nature of products, ranging from ease of storage and handling, ease of opening procedures, appropriateness for use in micro wave ovens or toaster ovens, etc. However these aspects form part of the appeal of a product to the consumers and so they play a part in product differentiation. Also such functional characteristics can be designated as the industrial property of a given party and are the object of applications and registrations for patents and practical new model status.

6) Disposability

Since packaging is not itself a commodity it is treated as refuse once it has fulfilled the functions for which it is designed. Traditionally disposal has taken the form of incineration or dumping (burying) but increasing environmental concern has meant that a number of characteristics relating to disposability are required to be met by packaging. Characteristics of easy retrievability and easy sortability are required in retrieval stages. In treatment stages environmental protection and recycling are increasingly demanded so that appropriateness to reuse or recycling is increasingly important. In the case of refuse which is to be buried, the incineration of as much of the refuse takes place prior to burial for the purposes of energy retrieval. The safe incinerability of packaging is an important issue, and plastics are required which give off low quantities of heat in order to reduce the wear on incineration equipment, and inorganic fillers or modifications of materials are carried out.

(2) Technical trends in food packaging

1) Packaging materials

Rather than development of new blank materials recent innovations in food packaging materials tend to be an increase in the available grades of already existing blank materials and diversification of material characteristics to render them compatible with a wide range of processing alternatives. Such developments focus on application development in order to make the use of materials in new fields possible.

As a result there has been virtually no increase in recent years in the actual categories of blank materials which are used or in the varicties of packaging materials used for food packaging. However, a widely diversified range of uses for the same materials has been realized.

Many of the characteristics demanded of food packaging materials depend on the physical and chemical properties of the materials being used and so in many cases it is often possible to substitute blank materials of similar nature for each other. In view of the cost effectiveness of packaging a large range of packaging materials have been developed and applied. Thus the optimum packaging material for the same content product supplied by the same manufacturer will differ according to the market being considered.

The mainstay of packaging material development is for relatively inexpensive general purpose packaging materials, and the main focus of attention is on assuring that these provide the necessary characteristics mentioned previously. With aluminum, steel or other metals and glass the amount of material used is related to the cost and

disposability of these materials as packaging, so development has concentrated on technology for reducing the quantity of material which must be used. With paper, development has focused on reducing heat discharge at incineration, improving the ease of recycling, and remedying the inherent lack of shaping strength and the low barrier performing properties of the material by combining the use of paper with other packaging materials. The main focus of technical development in plastics has been to ameliorate the processing potential and most attention has been given to increasing its fluidity during heat processing and its moulding properties and appropriateness for lamination. Further development involving the combination of various packaging materials to produce packaging containers and envelopes are often due to end users or in order to improve the content preserving properties. Developments are therefore mostly undertaken in response to changes in consumer patterns or distribution systems. The diffusion of microwave ovens and the spread of convenience store outlets in recent years have had considerable influence on the development of packaging. As a result compatibility with microwave ovens, convenience and ready to eat (RTE) properties are important issues in packaging evaluation nowadays.

2) Packaging machinery

Heretofore the machinery used for food processing has been independent from that used for packaging stages, so that the finished food item has simply been packaged. However, in recent years there have been modifications resulting in the inclusion of packaging machinery as part of the food processing treatment systems.

Also in terms of control mechanisms there has been a move away from the mechanical, electrical control and working systems towards the introduction of new control systems involving microprocessors and computer technology, and linear motors, etc. have been introduced as motor power. The appearance of such packaging machinery has rendered the presence of skilled operational directors less essential and has also resulted in a shift of emphasis in maintenance technology away from machine engineering technology towards advanced electronic technology. As a result of these shifts the importance of specialist maintenance services has increased. Further, actual operators are required to have a certain degree of computer expertise and maintenance skill in order to carry out trouble shooting and maintenance operations using computers in the case of computer assisted packaging machinery.

3) Packaging technology

Changes in market needs exercise an influence on food processing technology which in turn has an effect on packaging technology.

The main focus in food processing technology is directed to the two tasks of rendering the content foods as fresh as possible, and ready to eat. The processing methods traditionally adopted to respond to these problems such as drying or canning involved a single processing method which completed processing in one stage but which also sacrificed the particular characteristics of the food item concerned to a certain extent. Such single processing has been increasingly replaced by team work processing which involves the combined application of several types of processing technology in order to complete processing targets, such as clean packaging or modified atmosphere packaging. This team work multiple processing results in less loss of the particular characteristics of the food being processed.

Response to market needs has not only been undertaken in food processing. Responses have also been made in the field of distribution processes to reduce distribution time and maintain product quality through the adoption of various delivery methods which help realize the provision of food products in fresh or RTE condition.

Food packaging responding to such trends has moved away from the "shield" concept of packaging based on realizing the protection of product quality. This protecting function is increasingly met by processing and distribution methods as well as by packaging, which in turn gives increasing emphasis to convenience and lightweight packaging.

Moreover environmental issues and conditions are given greater emphasis as shown in the following section.

(3) Environmental protection and food packaging

Modern packaging poses a number of problems in relation to environmental protection. Since the original function of packaging is to protect the contents of the package this constitutes a subsidiary function. Consumers purchasing the desired contents end up buying the package which contains this. Therefore once the contents have been used and consumed the package naturally becomes unnecessary and is disposed of as refuse. This refuse packaging creates problems of environmental pollution.

However such environmental pollution caused by refuse packaging is not the only problem related to packaging. Production of packaging materials relates to the problem of protecting the natural forestry resources which supply raw materials, to the environmental pollution occurring in connection with packaging manufacture and to energy consumption. The refuse resulting from food packaging is a very visible and often encountered aspect of everyday life and though there is much misunderstanding about the actual share of domestic refuse accounted for by such packaging refuse and the

degree of influence this has on environmental destruction, the problem is very noticeable and easily becomes the focus of public attention.

Heretofore the cost of packaging has been calculated as the cost of producing completed packaging items. However, with the introduction of environmental assessment there is a trend to evaluate the cost of packaging in terms of the whole life cycle and to include the costs of disposal, recycling, reuse, etc. which accompany this. However, it is extremely difficult to set standards for a quantitative evaluation of recycling potential or disposability, and it is expected that the establishment of standards which can be generally accepted will require considerable time.

3.2.3.2 Current situation of packaging in Singapore

(1) Processing and distribution of packaged foods

1) Outline

The scale of production of Singapore's food industries including those for drinks is 2.5 billion US $ (about 200 billion yen) with 55% of food items and 30% of drink items being directly exported. There have not been any large changes noticeable in the scale and export ratios for solid food items but the output of and share of exports accounted for by drinks is increasing.

EDB data reports[8] that production is modern and efficient in the fields of chocolate, fruit juice, edible oils, refrigerated seafoods, convenience foods, flavorings, etc. and that product quality for these items is reliable. However the data provided is basically restricted to MNC food industries and in the case of 100% locally owned industries for the above sectors judging on the basis of local products actually sold in local supermarkets, quality levels do not generally reach those of similar products in the advanced industrial nations.

Food and drink products for export are mostly manufactured on a commissioned contractual basis or on an OEM basis in line with the client's brand specifications and excepting the MNC which have locally located factories none of the manufacturers export on the basis of their own exclusive brand export specifications.

The foreign affiliate food industries which have local factories have a network of business sites located in Asia and they produce and deliver fruit juice, sauce, fruits, frozen foods to their contract packers.

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8) EDB, "Report on the Census of Industrial Production"

The range of processing technology covered by food industries of Singapore seems to be limited to the following sectors;

a) products using simple already established processing technology
b) products which can be produced in small lots
c) Chinese ethnic food products

The packaging technology used is largely of a type which permits the desired targets and technical levels to be reached immediately after introduction of the technology systems. There is very little development of the technology in order to develop particularized operational settings or in house quality control technology to evolve a specialized company technology. Most products fall into one of the following classical categories;

a) canned or bottled foods and drinks
b) packaged aseptic drinks
c) dried foods
d) frozen foods
e) foods with stable components (oils, etc.)

Some companies possess an in-house framework for product Research and Development and carry out development activities but systems development (including packaging) is not carried out anywhere. The risk involved in the adoption of new packaging systems which involves research and development is much too high for companies with such a research and development framework. Consequently companies necessarily employ only those systems for which technology is firmly established and for which there already exists a sufficient accumulation of application history. The companies therefore follow a turnkey method and limit their purchase of equipment to items for which the relevant technology can be simultaneously introduced at the time of purchase.

Efforts to improve product recipes, packaging forms and packaging designs are made in line with market demands, and there are several success stories in the sectors of cakes, pouch packed foods, and drinks,etc. However, in view of the present standards of packaging technology prevailing it would be necessary in many cases to have packaging materials supplied in the end market in order to adequately meet market demands in the case of the Japanese market for example.

The most important characteristics of domestic food distribution networks are the growing relative importance of supermarkets and the large number of imported foodstuffs. As regards food imports, despite the increased buying power of Singapore consumers there is still a strong price sensitivity and it remains difficult to import food products which have a high quality of packaging.

On the other hand, supermarkets are increasingly the main channel of distribution for packaged foods. Labour productivity in supermarkets is superior to that of department stores and the number of supermarkets continues to expand in line with the development of new residential areas.

Raw fruits are largely sold in municipally run markets. Such products are displaced unwrapped and loose on the market stalls. Most of these products are imported and they remain as packed in the exporting countries of origin. In addition to the use of cardboard boxes a large number of wooden boxes are used for this packaging. However, the use of bamboo baskets as packaging which is frequent in Malaysia and other neighboring countries was not observed.

2) Sauces and seasonings

There are a large number of flavoring items particular to Chinese, Malay, Thai and Indian cooking traditions prevalent in South East Asia. There are a variety of spices and menu items used in Chinese ethnic and Nonya cuisine. Exported items are distributed via special channels in overseas Chinatowns,etc. and not via general market channels.

a) Soups

The Company AA, a representative firm in this sector, is engaged in the production of canned soups on classical lines using a firmly established technology of retort processing. Since retort canning involves complete sterilization through heat treatment this company does not employ preserving additives or coloring in its products. Traditional three piece tin cans with surround paper labels are used. This company also produces the vegetables and other additional foods used in soups and assures their preservation by dehydration.

Japanese consumers dislike the change in taste which foods undergo with heat treatment and the changed texture which results from overheating. As a result many products are retort pouch packed products or come in aseptic packages, and the traditional retort canned products are losing their marketability. The technology for production of retort pouch packed products is similar to the technology for traditional

retort canning although there are some differences in equipment and the degree of difficulty posed by quality control. Since these products both locally produced and imported from Japan are sold in supermarkets in Singapore it should be relatively easy to diffuse technology if demand expands. However, aseptic packaging differs considerably from retort pouch packaging and its introduction will require a considerable investment in research and development.

b) Soup stock

Traditionally soup stock sold in Singapore includes dried small shrimps which are salted, and fish extract. These stocks are used as a seasoning in Chinese, Nonya and Malay cooking. These stocks are made either by powdering after drying or by fluidized bed drying in the case of local indigenous manufacturers, and probably by spray dry processing in the case of foreign affiliated manufacturers.

In Japan soup stocks have been traditionally obtained from dried bonito or dried seaweeds. In recent years a variety of product forms have been developed including powdered stock products made by spray dry processing and pulverization, or concentrated stocks made from the concentration of stock extracts, or liquid stocks in aseptic packing made with stock extracts. In the case of the dried powdered stocks technical aspects include the technology for flavor retention and prevention of oxidation, so that quality maintenance standards must be considered in addition to standards for product form. The technology for concentrated and aseptic products differs considerably from the technology involved in production of dried stocks.

c) Seasonings (soya sauce, chili sauce, ketchup)

Products in this sector have traditionally been sold in bottled form, and some products make use of preserving agents. The company AB and the company AC, representative manufacturers, are engaged in the production of exclusive brand products and OEM production for PB items sold in supermarkets, items for fast food stores and products in small single serve sachets for airline companies serving in-fight meals. These products are exported to the ASEAN countries, Japan, Australia, the USA and Europe mainly through distribution networks in Chinatowns and ethnic food markets and distribution of the products on general markets has not been developed.

Products in this sector do not differ in form very much from those sold in Japan but technical differences include the use of preserving agents and a certain inferiority regarding flavor quality.

d) Spices

The special spices used in Singapore and Malay cooking are produced and sold and a large output is consumed in the south Asian region including Singapore. Products are exported to the neighboring countries. The company AD produces a mixture of spices according to traditional methods. The company AE, another major firm, produces a mixture of spices which are similar to the spice products used in Chinese and south east Asian cooking, making use of cryocrushing technology which permits reduction of quality variations and applying the PF non toxic gas sterilization methods developed by Japanese and American firms. Quality control is also thoroughly applied to processing stages of production.

3) Frozen foods

Seafood products, seafood meatballs and fish slices in breadcrumbs (fish fingers) are also produced as well as precooked Ready to Eat products and TV dinners, etc. In terms of form these products are basically the same as equivalent refrigerated products sold in Japan excepting details of menu, and production technology applied in production is also the same.

Representative firms include the company BA (especially active in developing TV dinners) and the company BB (active in exporting squid and shrimp balls).

The frozen baked cakes and pastries of the company BC which are presented in EDB documents make use of quick freezing system. Such products are virtually non existent on the Japanese market but are sold widely on the American market. Quick freezing technology is essential to quality control of frozen food production and is used widely worldwide.

Further, freezing is used in the production of Chinese ethnic foods. The company BD for example exports spring rolls and other chines pastry items to Chinese communities in some twenty countries.

4) Seafoods and their processing

As mentioned in the previous section the company CA freezes and sells minced seafood products. Similarly the company CB processes seafood to produce frozen seafood balls, fillets, etc.

The company CC manufactures squid and shrimp balls on an OEM basis which are exported to Great Britain, France, the USA, Australia, East Africa and Eastern Europe. The company emphasizes the "fresh, high quality of ingredients", the " hygienic manufacturing conditions" and the "excellence of manufacturing equipment" in its marketing appeals.

Foreign affiliates include a subsidiary of the Japanese firm the company CD which was set up in 1982 to produce the minced seafood products used for boiled fish sausages, fish balls, and mock crab meat fingers.

5) Snack foods

Snack foods on the Singapore market can be roughly divided into two categories. First there are snacks such as potato chips or snacks made from corn extrudates similar to those found on the Japanese and American markets. Secondly there are dried seafoods, dried nuts and dried fruits (known as preserved fruits locally).

The cereal snacks of the company DA belong to the first category and are exported to Australia, Italy, and various South East Asian countries. Product quality is reported by the EDB data to be on a par with international levels. However, since the focus of quality control for such products on the Japanese market is on freshness, the time required for exports from Singapore to reach the market would probably be too great a handicap.

The second category of snacks are produced locally by some firms including the company DB, which produce preserved and dried items from the fruits and seafoods unique to the region and these are distributed locally and abroad through the special distribution channels existing for Chinese ethnic foods. Drying of foods is a traditional method of food preservation and there is little difference in the technical levels in particular countries. However recently in Japan the use of PH adjustment via organic acids, and microorganism control via packaging technology has meant that the water content of items can be increased and foodstuffs which are fresh and soft can be manufactured. Such foodstuffs appeal to consumer preferences. Maintenance of product quality of fruit items is carried out by PH adjusting with organic acids and

addition of anti oxidation agents such as sulfur dioxide. In Japan, the USA and Europe canned fruits and desert products have been developed which preserve the natural flavor of the fruits after heat treatment. In comparison with such products the processing technology and preservation technology for dried fruits is seen to lag behind.

6) Oils and fats

Oils products are not restricted to the tropical oils such as palm or coconut oil produced in Malaysia or the Philippines. Edible oils are refined and processed using imports from oil exporting countries such as the USA, etc. to produce oil products. Some edible oil firms receive technical guidance from Japanese firms and there are some Japanese firms which have started local production. Such firms possess the latest technology for refining and product amelioration. However, judging from the products sold in retail stores locally or on overseas markets such as the Middle East the technical levels for quality control, production technology, packaging, product preservation, etc. are inferior.

Major firms manufacture an exclusive line of brand products as well as OEM production. The scale of production is much smaller than that of edible oil manufacturers in the advanced industrial nations and there is little automation of processes.

7) Chocolates and confectioneries

A variety of cakes and confectioneries are produced in this sector, and a wide range in scale of production is evident among firms. The company EA (for chocolates and cakes), the company EB (for sweets), and the company EC (for biscuits) are representative confectionery manufacturers which are owned by Singapore capital. The company ED is a Japanese confectionery company making sweets, chocolate, biscuits and snacks which has started local production. The company EE carries out OEM production of fruit cake and part of its output is exported.

The local firm EF has recently fully computerized its flour factory producing ready to use cake mixture and it is reported to have renewed factory facilities, improved technical services and devoted greater energy to research and development.

The company EG, a manufacturer of baumkuchen has a OEM basis contract manufacturing for a MNC and seems to have reached a satisfactory technical level. Further, the company EH has recently purchased a computerized form-fill-seal (FFS) packaging machine for pillow type packaging, and the firm shows strong interest in technical renovation and improving productivity.

The example of the company EI is given for its successful development of graphic design in cooperation with its Japanese user. The design concept was put forward by the Singapore side and art work, printing, etc. was taken care of by the importing Japanese firm. There were other examples noted in which design work stages from original art work to printing of packaging was carried out in Singapore in consultation with product users.

Technical levels for product quality and packaging quality in the case of Japanese affiliates and firms exporting output are assumed to be up to international standards but the product processing and quality control of other firms varies from company to company. In Japan there are a large number of middle and small size firms in the confectionery sector. In the traditional confectionery sectors it is supposed that technical levels do not vary to any great degree from one firm to another. The raw material flour, sugar and milk products can be obtained at cheap prices in Singapore and this is a major factor encouraging the entry of foreign affiliates. However, the humid tropical climate is undesirable for preservation of product quality and this needs to be kept in mind for product quality control.

8) Milk products

The output of milk products is increasing annually, and this sector now accounts for 18% of the total output of foods. The raw materials used are imported from the neighboring countries of Australia, New Zealand and Malaysia. The main destinations of local production are Taiwan and Malaysia. In particular reexport of output to Taiwan is frequent. This pattern of export is also noticeable in other food sectors and reflects the particular diplomatic relations between the two economies.

The company FA and the company FB are representative firms in this sector. One third of the butter produced by the company FA is exported to Asia and the Middle East. The company FB manufactures products on a OEM basis for the company FC of the USA and the company FD of Hong Kong, and the main items exported are aseptic drinks such as milk, fruit juices and yoghurt products. Aseptic packaging is carried out with technology and systems introduced from Tetrapak Ltd. Levels are equivalent with those of American, European and Japanese firms. As regards content quality there is a certain looseness in quality standards for flavor aspects which tend to be of high consumer sensitivity, and attitudes seem to differ from those in Japan. This results in differences in the setting of limit dates for consumption of aseptic products which we

will consider later. Processing and packaging technology for powdered milk and butter is inferior to that in Japan.

The main locally produced items sold on the domestic market are milk drinks, butter and ice cream for which a high level of production technology is required. Processed cheese which requires a large production scale to be economic is imported from Oceania and Japan, etc. Recently firms of the Japanese Milk Product Industries have begun to make an entrance into Singapore markets.

9) Staple foods

The main foods concerned in this sector are vermicelli and Chinese noodles since these are popular national foods. The quality of Chinese noodles is considerably inferior to that in Japan. This difference in quality is seen to reflect differences in the quality demands of consumers, the market sales price and production technology. The price of Chinese noodles in the Japanese ramen noodle shop "Ramenya" operating locally is US $ 8–10 (600–800 yen) which is four to five times more expensive than the price of noodles in the hawker centers (US $ 1.50–3 OR 120–210 yen). There is a visible difference in the quality of the noodles served in taste and texture.

Many of the firms in this sector are on a small scale and a representative firm is the company GA. This firm manufactures vermicelli and Chinese noodles (in both dried and raw noodle form). Raw noodles are rarely seen in supermarkets or retail outlets but are widely used in food service outlets such as the eating houses and restaurants of hawker centers. Instant noodles are also manufactured. The company GB is a typical manufacturer producing mostly instant ramen in plastic pouches. 95% of output is exported and destination markets include Far Eastern countries, Australia, New Zealand, the Middle East, Europe, Canada and the USA. This firm is also investing in production equipment for the cup type noodle production and construction of a new modern factory has recently been completed. Japanese affiliate companies also carry out local production in this sector.

10) Drinks

The drinks sector can be roughly divided into the alcoholic and non-alcoholic drinks sectors. According to the 1990 Census on Industrial Output 78,6% of the output of alcoholic beverages was locally consumed while 65% of the output of non-alcoholic beverages was for domestic consumption. The remaining 35% of refreshment drinks were exported to countries throughout the world beginning with Bahrain, Hong Kong and Japan.

a) Alcoholic beverages (beer)

Beer is the most typical alcoholic beverage and the company HA produces two brand products. The company HB is a member of the large industrial group including the company HC, a large scale manufacturer of refreshment drinks. These beer products have been awarded prizes at International Beer Contests and production technology is seen to have attained a satisfactory level. Containers are not as varied as those used in Japan, and the main forms are the disposable aluminum can and the returnable glass bottle. Some of output is exported to Malaysia and Papua New Guinea.

b) Refreshment beverages

In addition to milk drinks and fruit drinks manufacturers the large scale firms such as the company HC and the company HD operate in this sector. The former is the largest refreshment drinks manufacturer in Singapore and it has a varied line of products including carbonated and non carbonated drinks, sports drinks, fruit juices, teas, ethnic drinks, mineral water, etc. as well carrying out production of products on license from foreign firms. The company has factories in Singapore, Malaysia, and the Negara Brunei Darussalam where production of in house brands are carried out. Export markets include Hong Kong, Taiwan, Japan, Australia, and Maldives. Products exported to Japan are manufactured OEM for. The other major firm in this sector, the company HD also produces a wide range of drinks including carbonated and non carbonated beverages, fruit juices, teas, ethnic beverages, etc. This company also carry out production of products licensed from overseas drinks manufacturers.

c) Instant mix drinks

In addition to refreshment drinks in liquid form some manufacturers produce coffee, tea and other beverages in powdered form. The company HE is a representative firm in this sector. This firm has recently invested in packaging machinery and in reducing energy consumption and aims to improve technical levels, upgrade product quality and better client services. As part of this overall program the company has recently switched from the use of aluminum film to sachets for packaging.

11) Vegetables and fruits

The majority of vegetables and fruits which are distributed and consumed in Singapore are imported from overseas, beginning with the surrounding countries.

The packaging used for transport of the vegetables and fruits is carried out by the exporting countries of origin and so these determine the technology and packaging material employed. Packaging material used for the transport of such import freight seen in marketplaces in Singapore were international standard containers and cushioning materials (with the exception of a certain amount of packaging materials used for imports from certain neighboring countries).

For domestic distribution purposes products are increasingly repackaged into units for sale to large scale supermarkets. However, the traditional type open stall markets (wet markets) were seen to use empty containers and goods were displayed in the import packages.

(2) Packaging forms and materials

The food processing technology applied in Singapore is either of a traditional nature or is of a technological type which is already sufficiently established. Packaging technology is also of a firmly established type. Packaging technology aiming at quality protection[9] is carried out for drinks in the form of canning, bottling or aseptic packaging, while secondary quality protection[10] covers dried foods, low water content foods, frozen foods, and foods with stable components such as edible oils. A variety of packaging materials (metals, plastics, paper) are used for these foodstuffs.

The biggest delivery problem for packaging materials in Singapore is a limit of sorts of packaging materials which can be obtained. There are factors relating to both the packaging industry and the end user industries which create this situation. The main factors concerned are;

1) the low cost of food items means that there are limits to the amount for packaging costs
2) there is insufficient diffusion of knowledge of the relation between packaging and product quality protection. Selection of packaging materials and machinery and management of packaging operations is often not carried out appropriately.
3) markets are very small in size and if fine distinctions in grading and defining of materials were carried out it would be difficult or impossible to meet the very small orders.

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9) Cases where packaging technology is indispensable for protecting the quality of products.

10) Cases where packaging technology plays a supplementary role in protecting the quality of products. For instance, decrease and concentration of water content, temperature for preservation, and the content themselves, are essential factor for keeping the quality of dry and watery food, frozen foods, and stable products such as edible oil, respectively.

4) processing technology and expertise for packaging materials is insufficient and it is not possible to adequately produce packaging materials appropriate for packaging containers.
5) raw materials of a cheap spot market nature are often used and systematic guidance is not provided by suppliers.

As a result of the above factors users do not provide sufficient data relating to the main materials, and processing conditions are inappropriate because of the strong cost sensitivity prevailing. This situation in turn gives rise to basic functional problems relating to transparency, lamination strength, or processing (e.g. printing stages).

As a concrete example the following problems are encountered in the supply of plastic film;

1) Limitations resulting from resin supply

Domestically produced, low cost PP and PE are mainly used and since import items such PET and nylon widely used in the advanced nations are expensive the application of such materials is extremely limited.

2) Grading

Appropriate grading in view of applications or object foodstuffs envisaged is left to the suppliers, and there is little clear awareness of this aspect among users.

3) Processing technology

Processing technology for packaging materials which users can select is limited in scope (lamination methods, part coating, etc.)

4) Performance

Since applicable auxiliary materials (adhesives, etc.) and processing technology on the part of converters are restricted there are problems in the basic performance of packaging materials available (transparency, lamination strength, printing performance, etc.).

Packaging forms and materials used in the main product sectors are as follows;

1) Sauces and seasonings

a) Soup mixes

Tin (three piece) cans and TFS cans are used for canned products, but instead of direct can printing paper labels are employed. Printed cans are higher quality since they have a better printing finish, and discoloring and tearing are infrequent but cost

considerations and the small production lots in Singapore mean that direct printed cans are not employed.

Dehydrated powdered products are packaged in either plastic envelopes (PP/PE) in cartons or in glass jars and cartons. However, in order to reduce oxidation of the contents it is desirable to use high barrier materials (PVDC composite), since the gas barrier provided by plastic envelopes (PP/PE) is insufficient.

b) Seasonings

There are a variety of packaging containers for holding liquid seasonings depending on the quantity and contents concerned including glass bottles, glass jars, plastic bottles, cans (TFS), steel drums, etc. The blank materials employed for production of these containers are to international standards but the containers are sometimes technically inferior in terms of form and design.

Glass jars, glass bottles and cans (bulk), etc. are used for products in paste form. For powdered products plastic bags, glass jars, fiber glass drums with inner linings, etc. are used.

c) Spices

The main form of packaging material for spices are OPP/CPP and aluminum foil. In both cases problems with surface smoothness and print coloring were observed. Also OPP/CPP are insufficient as barrier materials to preserve the critically important aroma flavour of spices. Packaging materials with excellent aroma-flavor barrier performance such as PET, etc. should be considered for use.

2) Frozen foods

Packaging for frozen foods generally consists of either a carton with an aluminum service tray or an pillow shaped envelope of plastic film. In the case of plastic film packaging it would seem that some products were made from OPP/CPP materials not up to required cold resistance grades.

For TV dinner packaging a carton and an aluminum service tray divided into partitions is used. Such trays use PET in the USA since this is appropriate for both traditional and microwave ovens (dual ovenable). With frozen cakes packaging is generally of a loaf package form consisting of an aluminum tray a cardboard lid and a paper carton. There are also cylinder shape HIPS which are deep drawn containers of paper coated with OPP with attached lids. Also in recent years plastic cup containers with wedge shaped individual servings have also appeared on the Japanese and American markets.

As packaging for ethnic Chinese pastries such as spring rolls, a carton with a PVC thermo formed tray is employed. Packaging is basically similar to that employed on the Japanese market in terms of form but due to environmental considerations PP trays are widely used in Japan.

3) Seafoods and their processing

The majority of processed seafoods (usually minced seafood) is distributed frozen and a section of this output is marketed as refrigerator food. PE bags are used for frozen processed seafoods such as fillets and shrimps while cartons and OPP or PE film envelopes are used for packaging fish fingers and fish balls. Laminated bags of an OPP base are widely used for frozen processed foods and also for dried foods. In Japan frozen goods are packed not only in PE and OPP packaging, but also in bags of a nylon base which have an excellent pin hole resistance are used for low temperature goods according to the sales price of goods concerned.

4) Snacks

A wide variety of packaging forms and materials are used for snacks. Packaging for potato chips and corn snacks, etc. take the form of composite can boxes (paper, aluminum foil, and plastic film of composite material in envelope form), or of cartons (plastic liner bag and paper cartons), or of cup containers with lids (PE coated paper cup and a heat seal lid made of PE coated paper). The most widely employed form of packaging is the plastic bag. The above also applies for Japan. Materials used include plastic films (PET, OPP) with aluminum coating, composite aluminum foil with plastic film bag and film bags (OPP/PE) without aluminum foil, etc.

Nuts are another important snack product. Traditionally these have usually been packaged in soft packaging materials such as OPP/PE bags. Since the shelf life of such foods is short (two to three months) and taste deterioration upon oxidation is rapid nut snacks in Singapore are increasingly packaged in MA packaging using PET/ AL–met/PE and N 2 gas. The use of MA packaging extends the product shelf life to six months (Figure 3–2). Further deoxidizing agents are used in some products. The bags are judged to have reached a stable and satisfactory technical level but use is not yet widely diffused on the market.

Further, OPP/PE and OPP/CPP bags are used for dried seafoods and dried fruits but there are problems in the gas barrier used for preventing oxidation and it is desirable to employ bag materials with superior oxygen barrier performance.

5) Edible oils

Singapore produces the full range of edible plant oils beginning with such tropical oils as palm and coconut oil, and output is chiefly of vulcanized oils with hydrogen added. Metal cans are the main packaging form used (three piece cans, drum cans, gallon cans) but the use of blow molded PVC bottles and injection blow molded plastic bottles is increasing presumably in response to consumer demands for convenience to use forms of packaging. While PVC bottles are widely used in Singapore such bottles have been almost completely replaced by PET bottles in Japan.

In addition to edible oils margarine is also produced and this is packaged in cup containers formed of PVC or HIPS sheets. In Japan for such products frequent use of PP base materials with a high oil resistance and stability is common. Further, the thermo formed containers used in Japan for margarine, packed box lunches and side dishes are usually often formed from PP or HIPS sheets tempered with talc or other inorganic fillers to reduce the heat given out at incineration.

6) Chocolates and confectioneries

A wide variety of products are included in this sector and so packaging materials and forms vary widely. Looking at packaging used for individual products we find that in the case of biscuits a film envelope is used with either a carton or an overlap paper, while for sweets a film envelope and wrapper is used, with premixed products an all round seal film envelope (OPP/PP/PE) is used, for fruit cakes a can with an inner wrap lining or a cellophane/PE envelope and carton, for chocolates an aluminum wrapper and slip label or carton is usually used but plastic formed trays and cardboard boxes with lids for gift boxes, metal gift boxes, and paper or card board tube containers (spiral structure) are also commonly used. Gift boxes for these products are also packaged in cans with friction lids.

Powdered cocoa is packaged in containers with friction caps traditionally used for this item in America and Europe. There are soft fresh confectioneries special to the region of Singapore which are made from coconut milk and powdered rice which are packaged in a PVC tray and pillow shaped film bag (OPP/PE). PP cup containers with heat seal lids are used for the export of this confectionery, and lots are reheated by steaming after packaging to ensure product quality.

7) Milk products

For liquid products such as milk or milk based drinks which are refrigerator distributed widely used packaging includes cartons (paper/PE), plastic bottles (blow

molded), in line formed blow bottles (HIPS), etc. For products distributed at normal temperature FFS cartons (paper/aluminum foil/PE) is used for aseptic packaging. There is little difference in form or quality of materials between the packaging used in Singapore and their equivalents used in the USA or Japan.

A cup container is used for yoghurts which uses paper/PE for material. FFS type containers formed from plastic sheets using the system (HIPS/paper label) of the French company Elka were also noticeable on the market.

For ice cream either cup containers (paper/PE) or cartons (paper/PE) are used. Oil resistant composite materials (paper/aluminum foil) are used for butter and other oily products, but the cartons and plastic cups used in Japan were not employed. Further, BIB packaging (carton and bag) are used for packaging powdered products.

As packaging for flour in addition to paper bags with coatings, film bags (OPP/PE) are employed, while dried noodles are packaged in OPP/PE film bags , and instant noodles are packaged in OPP or PET/PE film bags. However, packaging material with a high gas barrier performance such as PVDC composite is not used. Foamed polystyrene cup containers are used to pack snack noodles.

9) Beverages

For beer TFS (3 piece) cans or aluminum DI (2 piece) cans and returnable glass bottles are used. These packaging forms are the same as those used in Japan but the range of volume sizes is more restricted in Singapore. Also there is no use made of one way bottles or plastic containers as found on the Japanese market.

The main forms of soft drink packaging are small volume TFS cans (3 pieces), returnable or one way glass bottles, aseptic paper cartons (paper/aluminum foil/PE), large size PET and PVC bottles and one way glass bottles. Aluminum cans are only used for carbonated soft drinks on the domestic market.

For powdered beverage items such as instant coffee or tea mixes, sachets of paper with lacquer coating, or of composite aluminum foil are used for the inner packaging and paper cartons are used for the outer packaging.

10) Fruits and vegetables

Since almost all fruits and vegetables are imported the packaging forms provided by the exporting countries of origin are used as they are. Cardboard boxes with perborations or windows are most common but plastic crates and wooden boxes as well as bamboo boxes particular to this region are also used for part of imports. Plastic or

chipboard trays are used as packaging for fruits and polystyrene cushions are provided to reduce or prevent product damage from shock and vibration during transport.

11) Packaging materials for export items

Materials used for the transportation of foods in Singapore include cardboard boxes, plastic crates, wooden boxes and bamboo baskets, etc. Cardboard boxes are usually used for processed foods while for agricultural products in addition to cardboard boxes plastic crates, etc. are used for short distance transport. The use of wooden crates and bamboo baskets is not very common.

Cardboard boxes often use liners of recycled paper and there are problems in moisture absorbing performance and pressure resistance. However such defects are unlikely to be promptly remedied in view of the availability of materials and cost considerations. There are also some problems in material quality and form regarding the plastic packaging but fundamental problems are infrequent.

(3) Packaging technology and product quality

The Table 3-11 presents the categories into which processed foods in Singapore can be divided according to evaluation parameters for packaging form, packaging quality, product quality of actual content foodstuffs, sales markets, etc. Category 1 consists of those packaging forms, packaging quality, etc. which are up to world class standards, and so can be sold on international markets. Representative items of products. Category 2 consists of items which are of world class standard in terms of packaging form but which are second class as regards packaging quality or content quality, and the majority of processed foodstuffs currently exported to Chinese foodstuff markets belong to this category. Category 3 consists of items whose packaging is below world class levels and so these items can only be sold on domestic markets. Raw noodles and soft fresh sweets belong to this category.

The packaging technology applied in Singapore is of a conventional type which has already been firmly tested and established. Despite this judging from the quality of the food items sold in domestic supermarkets and open stall markets or served in restaurants or the hawker centers the packaging technology does not seem to be very sophisticated and the products are not produced with sufficient quality control. This results in frequent cases of defective taste and aroma caused by oxidation or impurities.

In the food industry licensing out is accorded to those factories which are devoting energies to upgrading product quality and which have reached GMP standards set by the Department of the Environment. Some firms producing beer or confectioneries have

received international awards such as the Monde World Selection. Investment in the latest technology and in equipment and machinery is also evident in the sectors producing spices, flavorings and seafoods.

Despite these efforts the fact that many items have not yet reached international levels of quality reflects the different national and cultural attitudes to foods. Consumers do not necessarily demand that products attain international quality levels.

Since the domestic market in Singapore is restricted, firms must normally keep in mind overseas sales and yet product quality remains insufficient to satisfy the demands of international markets. In order to remedy this situation the following factors are considered necessary.

Firstly, the lack of related technological expertise, information and systems support means that effective development of products and technologies meeting market demands does not take place. Therefore, the effectiveness of food packaging technology, food processing technology and quality control technology is inferior to international standards and an important task is the upgrading of these support systems. However, low product pricing and belatedness of mechanization are part of the economic situation in Singapore making active and energetic investment difficult to realize. These factors act as obstacles to the effective market impact of the aforesaid technology upgrading and so must be considered.

Secondly, market orientated packaging is insufficient. Reinforcement of marketing packaging is essential to promotion of exports and improvements in product quality, packaging forms, graphic design and export packaging are needed. To realize the above it will be necessary to undertake research of imported foodstuff samples, encourage more exchanges with western and Japanese designers, introduce technologies related to packaging forms, and carry out trend surveys and marketing research on target markets.

Thirdly, information concerning export markets is insufficient. It is necessary to carry out preliminary surveys and reports to identify the legal regulations and restrictions of target countries, customs categories, items with import restrictions, and the specification standards used for conducting import controls and checks on quality specifications, additives, labels and indications, packaging, etc. (inspections relating to specifications such as safety and hygiene).

The Green Plan developed by Singapore puts emphasis on the following points for inspection of food hygiene;

1) checking for disease causing bacteria in fresh food products
2) inspection of chemical substances used to preserve foodstuffs
3) fertilizers used for harvested foodstuffs
4) the presence of fertilizer residue or cancer-organic substances in food items

5) transfer of chemical substances from packaging to food items.

With regard to this fifth item of possible transfer of chemical substances from the packaging to the content foodstuffs such problems have actually been encountered with the stretch film used for tray packs. Incidence of such transfer has resulted in the recall of commodities and this suggests that it is necessary to upgrade quality control standards for packaging materials.

In the Green Plan the following points are emphasized as a focus for consumer education regarding label indications.

1) diffusion of nutritional awareness and understanding
2) education on how labels are to be read
3) teaching the correct use and purchase of foodstuffs

Fourthly, export packaging is not appropriate or adequate. For example, cardboard boxes have defective folding because of defective flap infolding operations, palette stacks collapse or are ineffective because of incorrect stacking methods, cardboard boxes absorb moisture or get wet because shipping and loading is done outdoors even in rainy weather. The first step towards remedying such problems is the upgrading of quality awareness.

(4) Responses to environmental problems

Singapore is a nation with limited territory and so incineration is a more effective way of treating disposal than burying in rubbish tips. Effective use of the energy produced by incineration of refuse disposal is also an important aim. Basically the following three points can be listed as important policies concerning refuse disposal.

1) use of packaging materials as fuel
2) reduce the amount of raw refuse by reinforcing drainage systems
3) reduce the amount of non incinerate refuse

The National Development Program for Singapore foresees a 1.3 million strong expansion over the current population level and the government plans to keep the environmental effect of this population increase within appropriate limits by an effective management of national territorial resources (Table 3–12). The current dumping sites used for dumping of solid wastes are expected to be full by 1997. The quantity of refuse which can not be incinerated and so must be buried in dump sites is to be kept down. At present 60% of solid refuse is incinerated at two refuse treatment plants and the heat

given out is used for electric generation while metal scrap is recovered. Further a third refuse plant is under construction and when this has been completed it will be possible to incinerate 85% of the total solid refuse. It is also planned to prepare a dumping site at the coastal location of Plau Semakau to come into operation after 1997.

Refuse reduction is to be realized through education, reuse and recycling activities. Singapore's refuse output has increased annually an average 8.2% since the 1980s and reached the 2.08 million ton level in 1990. Of this some 1.03 is domestic refuse amounting to a per capita daily average of 1.1 kg. The government aims to bring this domestic refuse output to a per capita level of 0.9 kg. daily (representing an 18% reduction over present levels). By 1995 refuse is to reduced by a program including reuse of wastes and refuse, promotion of recycling operations (at present paper and iron are recycled), reinforcement for production and distribution of governmental packaging and automation of food item production.

Furthermore establishment of a "Green Mark" system, and development and promotion of environmentally friendly products and machinery is to be carried out. The following four conditions must be realized for display of the green mark. The conditions have a strong relation to the development and improvement of packaging materials, technology and machinery.

1) products which contain a large share of reused or recycled materials
2) products made from materials which are environmentally friendly
3) machinery which does not produce noise
4) energy saving products

3.2.3.3 Characteristics of packaging in Singapore

When looking at the nature of food packaging in Singapore it is necessary to take into consideration particular national characteristics such as the natural environment, the socioeconomic context, market particularities, limits of packaging production technology, limits to food processing technology and quality control technology, etc. as well as the general nature of the food packaging itself.

(1) Natural and socio-economic context

Singapore is an equatorial country with a tropical climate of high humidity and temperatures close on 30 degrees c. even in the rainy season. Obviously in such a humid climate the effect of humidity on packaging materials and on the deterioration of foodstuffs must be given ample attention.

As regards distribution networks food packaging has no serious problems. Since national territory is quite small and road systems are well developed, it is possible to reach all areas from the central island area by car in a matter of thirty minutes or so. Moreover, there is considerable transport of exports and imports by truck to and from adjoining Malaysia.

A large amount of shipping passes through Singapore as an intermediate port connecting the Indian and South China Seas. Reloading and repacking operations are carried out for such freight.

The transport and distribution of food items is quite simple and poses almost no logistical difficulties within Singapore territory given the short distances and the available distribution networks. Product design is therefore unaffected by distribution considerations. Further since sea transport is usual in the case of exports problems are rarely encountered.

The sole important problem is posed by the small size of freight shipments exported to neighboring islands and the truck shipments to the Malay peninsula. In particular, shipping distances to the Malay peninsula destinations are long and transport conditions harsh, and such conditions are expected to have an influence on product design for foodstuffs.

On the other hand population factors create considerable restrictions on food packaging. Packaging materials suited to economic production lots with a population of 2.7 million are limited. Consequently the supply of packaging materials which meet the particular conditions and demands of the various foodstuffs is not easy to realize given the scale of national users taken in isolation. Further, rather than produce packaging materials locally it is more economical to import some materials from abroad but in such cases it is difficult for such materials to meet exactly the demands of local users and there are restrictions on the quality preserving and protecting functions of such packaging materials.

Technical supervision is an effective way of upgrading the level of packaging technology but there are limits to the scope of such activity given the limited size of the domestic market. Therefore in order to realize economies of scale for equipment introduced if operations are restricted solely to the Singapore market, and so sales to surrounding countries becomes essential.

Since population is small the cost of labour is found to increase rapidly as industries realize rapid growth and so there is a likelihood that production investment carried out on the assumption of cheap labor will shift to surrounding countries. In particular, such

base shifting readily occurs in cases where the latest technology for support systems is introduced. Many of the food industries involve comparatively simple production equipment and technology levels required are not that high so that the barrier to new participation is low. In such industries base shifting occurs very easily.

(2) Market characteristics

The influence of market characteristic can be roughly divided into those which are related to the context of domestic market and those related to the context of export markets.

1) Domestic markets

The quality levels of processed foodstuffs which are demanded on Singapore markets are different from those demanded on the Japanese market. Although there is little difference in actual packaging forms there are considerable differences in the acceptable levels of quality control for the materials, molds and printing, etc. The basic functions to be met by packaging are not regarded as scrupulously as they are in Japan. This is taken to be largely the result of the different consumer demands regarding quality control. If products packaged to Japanese standards were introduced into Singapore these might be seen by consumers as excessive in their quality specifications and create the impression of being over packaged. This needs to be kept in mind in marketing.

The prices of processed foodstuffs and packaged food items sold in Singapore are several times lower than the prices in Japan. Packaging costs are necessarily low when market prices are low and this effects the quality of packaging materials which can be used. The ratio of overall costs accounted for by packaging materials in Singapore is around 10% of food item production costs and 32 % of beverage production both of which figures are several percent higher than the corresponding figures in Japan. In particular, the ratio is particularly high for bottled and canned beverages whose selling price is restricted (40%), for soya sauce (25%), for oils and fats other than tropical types (23%), and for biscuits (21%). In contrast, for food items whose price is relatively high the share of production costs accounted for by packaging materials is low, being 4% in the case of sausages, 4% for canned seafood, 4% for cakes and confectioneries, 5% for chocolates, 3% for seasonings, etc. However since the prices for such items are comparatively high the actual cost of packaging itself is relatively large and the required levels of quality are apparently satisfied. Levels are problematic in cases where the both sales price concerned and also the ratio spent of packaging is low such as is the case with noodles (7%), soya bean items (8%), are prepared foods (9%). In the case of such items it is difficult to ensure product quality given the limits

on the money which can be spent on packaging, and problems of quality frequently arise.

Few firms seem to be aware of marketing importance and the marketing role of packaging is no appreciated sufficiently perhaps because many of the food item manufacturers are middle or small size. Another reason may be the fact that selling is usually done on a direct personal basis through distribution outlets such as general stores, open markets, eating centers, etc. However, as sales to self service outlets such as supermarkets become increasingly central it is importance to appreciate the importance of marketing.

Retail outlets are increasingly shifting from such conventional retail shops as open stall markets, eating centers and general stores to the supermarkets. However, the number of stores where self service buying is practiced is still limited to 136 including that of department stores. Even Cold Storage Retail and Smart Supermarket Co., the leading supermarket chains, have developed their stores more or less 10 only, respectively. Convenience stores such as Seven Eleven are starting to make headway and more than 60 such stores have been developed including other chain stores. The display of goods is the same as that practiced in such stores in Japan. However packaging of the easy open type requiring sophisticated quality control is not widespread. Individual unit prices are between 30 and 35 US $ (2,300 to 2,800 yen) and in comparison with general supermarkets the percentage distribution of imported goods is shown in Table 3–13.

The UPC attachment rate is around 40%, but POS management making use of this is still either in a stage of evaluating whether it will be adopted, or just starting to use.

The purchasing behavior of consumers is influenced by packaging. Consumers believe that food items in stall markets are fresher than those sold in supermarkets and that unwrapped ham and sausages sold by weight are tastier than packaged varieties. Moreover consumers in Singapore desire to see what they are buying so transparent packaging or packaging with inspection windows are widely used though these transparent surfaces exposed to fluorescent lighting give rise to discoloring and oxidation and so make more likely quality deterioration.

2) Export markets

The quality levels demanded of export products are determined by the destination markets. For example when contemplating exports to Japan the products whose domestic packaging is sufficient for export are limited. In cases where the quality control and packaging technology of the country of origin are unsatisfactory products

which have been bulk packed are imported instead of finished products and after conducting a quality control check packaging materials supplied in Japan are used to pack products individually. Packaging is also sometimes provided to producers from suppliers in the target export markets if the export of finished products is economically viable.

3) Availability of special packaging materials

Since the population of Singapore is only 2.7 million there are a large number of products for which production lots are small and this is also true for packaging materials. In some foods where it is necessary to obtain packaging materials for lots which do not satisfy minimum lot sizes, second grade materials are employed and plain packaging materials are labeled.

Since the domestic market is small it is necessary to take the demand of neighboring countries into consideration when planning production of packaging materials. However customs on packaging film imports coming from Singapore in surrounding countries are very high (35% for exports to Malaysia, and 50% for exports to Indonesia) so that packaging materials tend to move from surrounding countries into the free port area of Singapore rather than vice versa. Singapore is an open market and has even become a dumping market with cheap packaging materials flowing in for converting use. In particular packaging film for laminating applications is all from imports coming from the following countries;

1) OPP: Indonesia, Malaysia, South Korea, Taiwan, Australia
2) CPP: South Korea, Thailand
3) PA: Japan
4) PET: Japan, the EC, South Korea
5) EVOH: unidentified
6) aluminum metallized film: Indonesia, Malaysia, the Philippine

As a result of the above availability context Singapore makes use of large amounts of OPP as a basic material. Another trend is the frequent use of CPP in sealant layers with a OPP/CPP composition. OPP/CPP have excellent anti humidity performance and so are well suited to packaging material use in the humid tropical climate of Singapore. However the low gas barrier performance results in oxidation and product deterioration. Some manufacturers make use of packaging film composed of OPP/CPP for packaging for frozen food but CPP generally (though this depends on the grade) has a poor cold resisting performance and so makes a poor packaging material for frozen foods. It is desirable to have a variety of different grade films available for each basic material

from which users can select the grade best suited to their needs but in small scale markets there are limits to such choice.

Further, the glass bottles and jars, etc. used in large quantities as containers for seasonings, beer, soft drinks, etc. were formerly produced in Singapore but these are now all imported. The suppliers of exports are determined in line with the quantities and form required. In the case of importing large lots, manufacturers in Malaysia or Thailand are chosen but for small lot production Taiwan manufacturers are considered more suited.

4) Quality requirements of the market

The quality of foodstuffs acceptable on a market differ in accordance with the market requirements prevailing, and cultural and social factors as well as economic considerations play a part in determining these. The "best eaten before" deadlines indicated on packaging reflect such thinking about product quality and there is a considerable difference on such points between the market requirements in Japan and Singapore.

For example the acceptable consumption period for aseptically packaged beverages in paper containers is indicated as two to three months in Japan but this becomes 12 to 18 months in Singapore. This is probably due to the different quality control items forming the basis for determining the acceptable period. The following quality criteria for determining good taste are shown in Table 3-14. The criteria of higher sensory level is used in Japan to determine acceptable periods while the lower sensory level is used in Singapore.

(3) Limits to packaging material production technology

In terms of converting technology the laminating strength of many films is weak. Further the strength of the heat seal of many packages is insufficient or the sealing notch of packages does not break away well at opening, and these problems are partly due to insufficient laminating strength.

To upgrade converting technology it is necessary to undertake a balanced upgrading of peripheral technology for adhesives and surface treatment at the same time. However, this balanced upgrading is not realized in Singapore at present. Further, there is a lot of job hopping which causes discontinuity in the expertise in production sites and the technical expertise of managers is not sufficiently transmitted to operators at actual work sites.

Badly printed products were occasionally observed on the market, as a result of insufficient quality control of printing operations. Further since the quality of the photos taken by manufacturers currently varies widely it is considered advisable to employ the design services of packaging material manufacturers in order to upgrade the quality of graphic design. However there is reported to be considerable differences regarding the designing technology these possess.

Provided that samples and models are available some sort of design response on the part of converters can be achieved but current efforts have not yet reached an original level of graphic design. Also CAD (computer assisted design) is not carried out.

The specialist know how and supports relating to barrier property, material characteristics, changes which occur to packaging material characteristics when these are used in packaging products, etc. which the convertor should provide to users who have chosen to use their packaging materials is lacking. As a result the most appropriate materials are not selected by users in many cases.

Moreover neither packaging material manufacturers nor food manufacturers seem to be very concerned about safety or hygiene and specialist expertise concerning these aspects is insufficient. Recently the transfer of plasticizer from packaging films to the raw foods in supermarkets placed in store packaging (PSP tray with a film wrap) has caused trouble and there have been cases where commodities have been recalled.As consumer awareness about packaging increases the importance of quality control in these domains can be expected to increase.

The quality limits of packaging materials also have an influence on the transport of packaging. Many manufacturers make use of cardboard boxes as shipping containers. But defective quality control of corrugate forming in the production stages and defects in the lining quality results in uneven fluting formation, squashed fluting and uneven layering so that the necessary strength of pressure resistance is not attained.

(4) Limitations of food processing technology and quality control technology

A satisfactory level of production technology and quality control technology has been reached in the food industries like western style confectionery and snack sectors but generally speaking there are still some points requiring improvement.

1) Limitations on selection of packaging materials

Since the factor of price is given more emphasis than quality control or grading when selecting plastic films and other packaging materials a wide diversity of quality results. Quality control of the materials which have been selected is necessary to remedy this situation but since this would involve technical problems and lead to cost

increases there is a danger that an appropriate response will not be taken. It is necessary to establish and diffuse the minimum basic expertise and know how of evaluation technology.

In general improvements in the quality of packaging materials require expertise on prevention of quality deterioration of packaged food contents or lengthening and stabilizing of shelf life, but this expertise is insufficient at present. Morcover there is little awareness of the need to improve product quality, and economic viability of packaging processing is given precedence.

Further, even if personnel responsible for research and development in the food industries possess a certain expertise relating to packaging technology they do not have actual experience in packaging development and so are in the dark as to how to proceed with packaging design. They are therefore forced to rely on convertors or packaging material suppliers.

2) Limitations in quality control of the food industries

Quality control of sealing is the most important aspect of quality control of packaging processing on site. If such control is poor the presence of impurities on seal surfaces leads to defective sealing which cause leakages, uneven seal quality, and other problems. It is necessary to improve quality control technology and its awareness among operators of packaging machinery.

The limitations of quality control in the food industries also has an effect on shipping packaging. Since the climate of Singapore is humid and hot it is difficult to maintain the required pressure resistance of cardboard boxes if these absorb moisture. Also since the cardboard box liner used in Singapore has a large recycled pulp content the water proof performance of this is poor compared to liner made from virgin pulp and so strength is greatly impaired by humidity. It is therefore necessary to avoid outdoor loading and shipping of boxes in rainy periods but often this is not kept in mind.

3) Limitations on production environment control

Balanced management of quality control of production processing of the foodstuffs and of quality control of packaging is necessary to improve protecting performance and product quality. There are many cases where upgrading the quality control of the production processing of the foodstuff is more effective than an improvement in packaging. Appropriate responses of this type are not taken because of the lack of systematic know how. Upgrading of microorganism quality by preventing

contamination of bacteria involves the implementation of the following measures as the first basic step.

a) processing layout check (product handling area, contaminated areas, clean areas)
b) isolation of factory atmosphere to prevent free inflow of external air
c) measures against insects and parasites
d) air conditioning
e) hand washing facilities
f) supervision of internal walls (against mold, damp, etc.)

3.2.3.4 Issues relating to packaging

It is necessary to determine the future trends of the food industry in Singapore since this will form the context for food packaging. Singapore is already losing its advantage as a production base where cheap labour is available. This is equally true for the food industries and labor intensive sectors of the industry are increasingly shifting to the surrounding countries. In the future firms with head offices in Singapore and production bases located in neighboring countries where cheap labour and raw materials are plentiful are expected to increase. Singapore must therefore endeavor to increase the value added accruing to the food industries through quality control (including that for packaging), management and technical activities.

A limiting factor on Singapore is the small scale of the domestic market. The population of 2.7 million is small and this fact needs to be kept in mind so that food industries and packaging technology which are viable in this context can be developed.

The following sectors of the food industry are considered viable for the Singapore market context in isolation.

1) Industries relating to basic foodstuffs which are consumed in large quantities such as noodles, staple foods, seasonings, etc. With such sectors it is necessary to give attention to the establishment of distribution and sales systems as well as to production aspects. Distribution systems will need to be of a daily basis since distribution distances and times are short.
2) The establishment of central kitchen industries to produce the pre cooked foodstuffs sold in convenience stores, etc. and used in fast food and restaurant chains, now beginning to appear. Whereas the industries relating to eating out in Singapore to date have developed around the private restaurants and the eating houses in the hawker centers the peripheral industries are expected to develop rapidly in the future and the central kitchen industries will expand.

3) Industries supplying minor daily foods such as tofu (bean curd), side dishes, and traditional cakes and dim sung, etc. Since products in these sectors can not be transported over long distances and the scale of firms is small they represent industries which are not suited to mass production. However, it will be necessary to undertake modifications in line with changes in transportation and selling methods.

In view of the above the following issues relating to Singapore's food packaging industries are to be noted.

(1) Upgrading of food quality

As mentioned above the production and processing technology for foodstuffs in Singapore is mainly of a well established traditional variety and not the latest technology available. The quality of the food items themselves is not particularly high and it is necessary to endeavor to upgrade quality levels.

Guidance in quality control for foodstuffs is required to effect such upgrading. Since it is necessary to take account of the social and cultural context influencing the levels of quality demanded of commodities sold domestically as well as economic factors such upgrading may not be immediately pressing. However, in the case of export items since product quality falls considerably below international levels it is necessary to undertake improvements. Further, the following aspects of hygiene must be given attention;

1) microorganisms
2) impurities
3) anti-insect and parasite measures
4) factory orderliness and cleanliness

In Japan inspections of imported foodstuffs are implemented and any items found below stipulated standards are refused entry. Items concerned include food additives such as preserving agents, etc. raw materials, and microorganisms, though the exact nature of regulations differ for individual food products. In particular, the domestic regulations established concerning changes in quality by microorganisms differ from those overseas in some cases and so special attention should be given to this aspect.

It is essential to carry out systematic training of operators, designate staff responsible for hygiene control and systematize quality control operations in order to upgrade quality levels.

(2) Upgrading of packaging quality

Factors influencing the improvement of packaging quality include packaging materials, packaging machinery, and packaging technology. The area of food packaging with the most room for improvement in Singapore is that for flexible packaging materials such as plastic films.

The first problem encountered is the delamination which occurs with laminated films (OPP/PE). Users rarely regard such occurrences as a problem. Moreover such problems tend to be unattended to as a result of the generally low level of quality awareness among consumers and the food industries.

Another problem concerning flexible packaging materials is the general use of materials of the same quality grade for a variety of differing applications. This is partly the result of the difficulty of producing a full range of blank materials and material grades given the small scale of production involved. However the particular characteristics of packaging materials are closely linked with the preservation of food quality and especially so in the case of flexible type packaging materials for processed foodstuffs. The first step for remedying this problem is to promote the diffusion of an understanding of the relation between packaging material characteristics and the preservation of food quality. It is also essential to promote the diffusion of the related auxiliary technology and the packaging technology used by such auxiliary technology. Greater awareness of the technical background will help prevent the selection of inappropriate packaging materials. For example, it will be possible to ensure that product quality is maintained and protected by the adoption of auxiliary protective technology in cases where this is necessary.

(3) Upgrading of packaging technology

At present much of the processing and packaging technology employed is of a traditional, well established type but in the future it will be necessary to acquire and develop the new technologies of processing and packaging. In this regard attitudes regarding the acquisition of new technology will play a fundamental role.

Packaging technology can be acquired along with the introduction of packaging machinery and packaging materials but in the case of the latest processing technology there are limits to such technology transfer. Technology transfer accompanying investment is rendered more likely in the case of joint venture undertakings with a long term perspective. Singapore's attitudes towards investment and the acquisition of know how and technology come under scrutiny in this context.

There are also aspects of technology upgrading which require the mastery of the technology in actual operating conditions. Simple introduction of a new equipment will not constitute acquisition of new technology in such cases. The technical mastery of the expertise relating to packaging equipment and materials can often be acquired by the simple introduction of new machinery. But the acquisition of the technical know how supporting quality control and operational systems is only gained through actual operations and so requires considerable time. However if the know how of these systems is not mastered then it is impossible to achieve the required technical levels for equipment and material technology, and there is a danger of rendering these latter aspects ineffective or insufficiently active.

(4) Upgrading of food processing and packaging expertise

Generally speaking know how tends to be superficial and sporadic since systematic know how in food processing and packaging has not been acquired. Technology relating to food processing, food preservation and food packaging involves a complicated synthesis of knowledge concerning food components and characteristics, microorganisms, oxidation, and other mechanisms of food deterioration, etc. and since the particularities of foods differ considerably it is impossible to obtain effective results without proper understanding of the above factors.

Therefore, it is necessary to ensure that know how relating to food processing and food packaging is acquired systematically. If basic expertise and know how are mastered the range of possible response is made much larger and it becomes possible to proceed with a more effective upgrading of overall product quality.

(5) Environmental measures

It is necessary to consider measures for responding to the two main environmental problems posed by the packaging industry that is, the reduction of refuse resulting directly from used packaging and secondly the reduction of the industrial waste accompanying the operation of packaging technology. The following measures are possible responses to the above;

1) The use of returnable plastic crates for fresh foods to reduce the amount of packaging refuse in the form of the cardboard boxes, cushioning materials, and bamboo containers currently used. This measure would also ensure a more efficient use of resources.
2) Reduction of the amount of refuse directly resulting from packaging by simplifying the packaging used for processed foods and improving distribution systems. Development of packaging material applications such as paper for one way containers,

plastic fillers made from materials easy to treat with excellent incinerability and low heat discharge on incineration, and replaceable filler packaging.

3) Promote energy recovery through incineration, recycling and improved, rationalized dumping site systems.

4) Development of packaging technology and systems to reduce content loss and improve protecting performance of packaging in the distribution and preservation stages.

   a) Reduction of refuse ratio by application of MA/CA packaging to maintain freshness of fruits and vegetables and lengthen the shelf life

   b) Reduce the amount of refuse by industrialization of pretreatment of fresh and raw foods. When pretreatment of fresh foods is carried out in homes large amounts of refuse result. Since most of this refuse is organic garbage problems result from incineration or dumping. When pretreatment is industrialized organic garbage does not arise in homes and the edible parts of fruits and vegetables are efficiently supplied. The production of auxiliary products from the refuse is also made possible.

In Singapore a Green Mark system has been established and this mark of approval is accorded to products, etc. which are environmentally friendly. Table 3-15 indicates the relation of the product characteristics eligible for the Green Mark and elements in packaging.

(6) Reinforcement of legal regulations and systems for protection of development technology

In addition to legal regulations concerning food packaging and packaging themselves, the legal regulations and systems pertaining to foods and other factors also come into play. The existence and nature of a patent system for the industrial rights and its international status is important. If the industrial rights are sufficiently protected then long term capital investment and joint development between packaging users and suppliers is facilitated.

3.3 Chemical and Pharmaceutical Industries

3.3.1 Major Trends in Chemical and Pharmaceutical Industries in Singapore

3.3.1.1 General background

Chemical products can be classified into various sub-groups according to production process, chemical composition, or application.

Chemical products are often classified by application for reporting and other purposes. 3 sub-groups, 1) industrial chemicals, 2) agricultural chemicals and fertilizers, and 3) pharmaceutical products, account for major portions of world output of chemical products[11]. Other items include rubber and plastics, paints and coatings, adhesives and sealants, and cosmetics.

Of the 3 major sub-groups, industrial chemicals are the largest. The value of industrial chemicals production in OECD countries amounts to approximately US$209 billion in 1988, accounting for 56% of a combined total of the 3 major sub-groups, in contrast to agricultural chemicals of US$44 billion (12%), and pharmaceutical products of US$119 billion (32%). (Table 3-16) While products by the chemical industry are used in all fields, they are largely consumed by the industry itself as intermediate products of diverse sub-sectors.

3.3.1.2 Geographical differences in chemical production and demand patterns

The chemical industry can be classified into the following three types according to characteristics related to production:

1) Chemical manufacturers which are capital intensive and find volume production capability as a major competitive advantage;
2) Those which supply chemical products that require technological development for the use as intermediate products or feedstock materials for industrial products, thus necessitating manufacturers to provide customized technical support service or joint product development with customers according to their specification requirements; and
3) Others

Traditionally, chemical manufacturers in "1)" have been concentrated in industrial countries who are major consumers. Also, production of chemical products in "2)" has

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[11] OECD (Organization for Economic Co-operation and Development), "Globalization of Industrial Activities," (1992: Paris)

mainly occurred in industrial countries where advanced technology is readily available. On the other hand, developing countries have had chemical industries in "3)", namely plastic processing, rubber, and some inorganic chemicals such as sulfuric acid, operated on a small scale.

After the 1970s, however, a significant gap arose between prices of petroleum products and natural gas – principal feedstock materials for the chemical industry – in producing countries, and those in industrial countries. That has prompted the chemical industry, including capital-intensive manufacturers, to increasingly relocate their production bases to countries producing feedstock materials.

At the same time, a noticeable change was observed in geographical distribution of demand for chemical products. As pointed out earlier, chemical products are widely used as feedstock materials and intermediate products, so that there has been large demand in industrial countries where many industrial users are located. Recently, however, demand in developing countries is on the rise. There are three reasons for this: 1) the remarkable progress of industrialization in less developed countries has boosted demand for chemical products used as feedstock materials; 2) consumption of agricultural chemicals and fertilizers has increased in LDCs in response to efforts to improve agricultural production; and 3) the improvement in living standards in LDCs has spurred demand for pharmaceutical products. In particular, agricultural chemicals and fertilizers have recorded the largest increase in share of world consumption; as shown in Table 3–17, non–OECD countries accounted for 34% of worldwide consumption of agricultural chemicals and fertilizers. On the other hand, shares of non–OECD countries in industrial chemical and pharmaceutical products are 24% and 27%, respectively.

3.3.1.3 Major trends in world trade of chemical products

Previously, chemical products have been mainly produced and consumed in industrial countries, so that they have been traded mostly between industrial countries, with small amounts being exported from industrial countries to less developed countries. Then, the shift of chemical production bases to countries producing raw materials, as well as the growing demand in LDCs, have increased the flow of chemical products from LDCs to industrial countries. Nevertheless, trade between industrial countries still accounts for major portions of world chemical trade. According to the OECD data, chemical products exported from OECD countries to non–OECD countries account for 28% of the total for industrial chemicals, 37% for agricultural chemicals and fertilizers, and 27% for pharmaceutical products.

EC countries, having large chemical industries, are the world largest exporter of chemical products. For instance, Switzerland exports 75% of its chemical products on a value basis, and the UK and Germany 60% each. And 40% of chemical exports from the EC countries are exported outside the EC. 60% of chemical exports from the entire Europe including non-EC countries are destined to non-OECD countries.

The U.S. exports 15% of its production. The country is a major producer and exporter of phosphatic fertilizer, and exports of agricultural chemicals and fertilizers as a percentage of domestic production are 30%, much higher than other chemical products. As for fertilizers, however, the country's share of world exports dropped from 30% in 1985 to 22% in 1988. U.S. exports of industrial chemicals as a percentage of production have been on the declining trend, partly due to limited production capacities (manufacturers have slashed their capacities under recession in the chemical industry since 1980) and partly due to increases in imports of ethylene and other organic chemicals. Similarly, the export/production ratio of pharmaceutical products has steadily declined and exports equaled to imports in 1988. U.S. exports to non-OECD countries are relatively small, accounting for 38% of total chemical exports. Of the country's chemical exports to non-OECD countries, Latin America represents 45%, Asia 39%, and Africa 5%.

Japan, once commanding a large share of world fertilizer (nitrogen) exports, has lost international competitiveness as a result of the rise in feedstock prices. Notably, the Japanese chemical industry has been increasingly relying on the domestic market, and exports dropped to 10% of total production (on a value basis) in 1988. Most of chemical exports are industrial chemicals. Japan's pharmaceutical products have made debut in the export market in the 1980s. Pharmaceutical exports are concentrated on a limited number of countries; in 1988, Japan's pharmaceutical trade with two major partners – the U.S. and Germany – accounted for 36% of total pharmaceutical exports and 48% of imports. 50% of exports are destined to non-OECD countries, of which over 30% go to NIEs.

Canada's chemical exports and imports are mainly done with the U.S., accounting for 63% and 75% of total, respectively. Major items are industrial chemicals and agricultural chemicals and fertilizers. Trade balance in pharmaceutical products is in deficit. Canada is the world largest exporter of potash fertilizers.

NIEs[12] account for relatively large portions of chemical exports to non-OECD countries, 28% of total chemical exports to OECD and non-OECD countries, or 8% of total exports from OECD countries. Most of chemical exports from NIEs to non-OECD countries are industrial chemicals.

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[12] Rep. of Korea, Taiwan, Singapore, Hong Kong, Brazil, and Mexico

NIEs export relatively small quantities of pharmaceutical products in the form of final products, as many Latin American and Asian countries import intermediate products for final processing locally. As a result, major pharmaceutical exports from OECD countries are destined to Africa and the Middle East.

Other non-OECD countries playing an important role in chemical trade are oil and natural gas producing countries. In particular, the Middle East oil producing countries, such as Saudi Arabia, Qatar, and Libya, hold a major share in industrial chemical exports. On the other hand, the former Soviet Union and Morocco are major exporters of agricultural chemical products, particularly fertilizers.

3.3.1.4 Overseas investment trends of the chemical industry

When chemical production was concentrated in industrial countries, which exported to the world market, overseas investment by chemical industries in OECD countries was mostly confined to other OECD countries. Then, with the changes in production and trade patterns as discussed above, investment to non-OECD countries expanded rapidly in the 1980s and onward, particularly in Asia where rapid growth of chemical demand is expected.

Overseas investments made by European and U.S. chemical companies in 1988 were US$40 billion and US$30 billion respectively. 75% of European investment were made in the U.S.

Overseas investment by the Japanese chemical industry has gradually increased since the early 1980s, but it still remains at US$2 billion and accounts for only 3% of Japan's total overseas investment. Nevertheless, moves by Japanese chemical companies indicate a future outlook for the chemical industry in Southeast Asia. In particular, the Japanese chemical industry is in the process of structural reform by relocating production of general chemicals to overseas, mainly Asian NIEs, while focusing on specialty products at domestic production bases. At present, Japanese chemical companies are planning to move marketing and technical service bases for products which require technical support service or joint product development, to NIEs and other countries where technical personnel can be obtained relatively easily.

Fertilizer and petrochemical industries are capital-intensive in upstream operations, so that production capacity constitutes a critical factor in maintaining their Competitive. In response, chemical manufacturers have been building plants to provide a scale of economy at the location near sources of feedstock materials or those having good market access.

Recently, however, chemical industries in industrial countries are shifting their strategic direction from volume products to value added ones. Since the development of

value added chemicals and pharmaceutical products involves large amounts of research and development expenditures, they are almost exclusively manufactured by companies operating globally. At the same time, production strategy is increasingly shifted from conventional integrated manufacturing to maximize output in one location, to a local production system under which only basic products are integrally manufactured at limited locations near feedstock sources and/or strategic distribution points, and final production is carried out near consuming areas for the benefit of value-added sales which combine technical support service. Products manufactured and distributed in this way include pharmaceuticals, agricultural chemicals, dyes, paints and adhesives. In particular, chemical companies in industrial countries have been making aggressive investment overseas in the pharmaceutical sector, partly because they have to comply with the regulations and standards that vary from one country to another, and partly because they have to pick up sales in each market, however they are small, in order to recoup their sizable R&D spending. As a result, pharmaceutical manufacturers opt to establish production (or preparation) facilities in most of countries where they operate.

3.3.2 Current State of Chemical and Pharmaceutical Industries in Singapore

3.3.2.1 General

Against a withdrawing of internationalization of world chemical industries, chemical and pharmaceutical industries in Singapore are classified into the following three types: 1) small-scale chemical manufacturers which serve local demand; 2) export-oriented chemical manufacturers located in a petrochemical complex; and 3) chemical and pharmaceutical manufacturers capable of providing technical support service to meet demand for value added products in Southeast Asia.

In Singapore, downstream chemical and allied industries producing industrial chemicals, coatings, pharmaceuticals, and rubber and plastic processing emerged in the late 1960s. In the mid-1970s, plants to produce intermediate products started commercial operation, including formaldehyde, alkyd resins, coating resins, phenol-formaldehyde resins, unsaturated polyester resins, and polyvinyl chloride. These plants were small and import most of feedstocks.

Then a major petrochemical complex in Melbau Island (Figure 3-3), which came on stream in 1984, initiated fundamental changes in the chemical industry in Singapore. While the traditional chemical industry mainly served the domestic market and some of neighboring markets, the new petrochemical complex has established itself as the export

industry targeting the U.S., Japan, and other markets having high growth potential, such as China, Hong Kong, and ASEAN countries.

At the same time, with the burgeoning demand for high-grade chemical and pharmaceutical products in Singapore and neighboring countries who undergo rapid industrialization, Singapore has been successfully attracting an increasing number of chemical and pharmaceutical manufacturers who position the country as their production and marketing bases which combine customized technical support service capabilities.

As seen in Table 3-18, the chemical industry in Singapore has been steadily growing. Between 1981 and 1990, the production[13] grew at an annual average rate of 17%. With very small domestic demand, most of chemical products manufactured in Singapore is exported. Also, the country serves as a major distribution center in the region and re-exports large amounts of products.

According to the statistics, Singapore has 455 chemical companies. This figure does not include 15 petroleum refining companies. Of total, 285 companies process synthetic resins, and 93 companies produce fine chemical products including paints and pharmaceuticals.

The number of employees per company is relatively small, 56 for industrial chemical manufacturers, 62 for paint and pharmaceutical, and 49 for plastics processing, compared to 95 for the entire manufacturing industry in Singapore. On the other hand, petroleum refining companies - mainly multinationals - employ slightly less than 3,300 persons on average. Thus chemical and pharmaceutical companies in Singapore, both foreign-owned and local, are mostly small or medium in size. This is because foreign-affiliated companies, with having large parent companies, supply a single or a limited number of products and serve relatively a small market.

The value added and sales per company are S$13.74 million and S$40.51 million, respectively, for industrial chemicals, S$11.69 million and S$20.1 million for fine chemicals, in contrast to merely S$1.89 million and S$5 million for plastics processing. The figures are even small for plastic film manufacturers, S$1.41 million and $4.9 million respectively.

Notably, the pharmaceutical industry shows large amounts of exports as a percentage of sales, as well as imports, reflecting characteristics of pharmaceutical manufacturers in NIEs who import and process intermediate products and sell finished products to the domestic and neighboring markets.

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13) A total of industrial chemicals and gas, paints and pharmaceuticals, and plastic products (source: EDB, "Report on the Census of Industrial Production)

Plastic manufacturers are in downstream portion of the petrochemical industry, showing relatively large sales per employee.

3.3.2.2 Petrochemical Industry

The petrochemical industry in Singapore is based on the petroleum refining industry which profits from locational advantages as a distribution center, using naphtha and LPG supplied from refineries. The petrochemical complex has continued production above its nominal capacity, driven by a rapid recovery of worldwide demand after 1985. Additional capacities were added in 1989.

At present, the world petrochemical industry is undergoing serious recession due to: 1) the steep rise in prices of petroleum products – feedstocks for petrochemical products – due to the Gulf Crisis in 1990 and the Gulf War followed; and 2) a sharp drop in prices of petrochemical products in 1991, partly due to sluggish demand as a result of recessions in the U.S. and other countries, and partly due to serious supplying condition caused by over capacity in countries including the U.S. and Rep. of Korea. Nevertheless, economic development of Southeast Asian countries is expected to exceed that of other regions in the future, so is growth of demand for petrochemical products. In this concern, petrochemical manufacturers in Japan, the U.S., and Europe are planning additional investment in Southeast Asia, and Singapore is receiving attention as a regional production base.

According to a Japanese survey conducted in 1991[14] , world ethylene demand will grow at an annual average rate 4.5% to reach 72 million tons in 1996[15] . And growth potential of the petrochemical industry in Asia is one focus of the survey report, which predicts that Asia's share of world petrochemical demand will grow to 21.8%, while Europe's share will be down to 25.4% and North America to 32.0%.

Ethylene is not suitable for transportation because of gaseous state at normal temperature, its demand depends upon operation of downstream plants in the same area. Also, demand for petrochemical products as a whole is governed by economic development in the same market, unless their prices do not fluctuate significantly. Prices of petrochemical products are influenced by those of their principal feedstock – petroleum, heavily affecting expansion and contraction of product demand.

Between 1984 and 1990, petrochemical demand (thus ethylene demand) grew rapidly worldwide mainly because of stabilization of crude oil prices at a low level and growth of

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14) "Supply and Demand Survey on Products" by Council on Industrial Structure of Japan, and media reports including the Chemical Daily.

15) World ethylene production increased from 54 million tons in 1989 to 57 million tons in 1991.

global economy. In Asia, robust economic growth in the Far East and Southeast Asia and steady development of heavily populated countries, including China, India, and Pakistan, have sustained strong demand for final products such as plastics and synthetic fiber, compared to other regions. The recent trend in petrochemical industries in Asian countries are discussed in the following paragraphs:

The Japanese petrochemical industry reached an ethylene production level of 6.14 million tons in 1991. Demand is expected to grow at slightly over 2% annually and will reach a 6 million ton level in 1996. Characteristically, the industry tends to emphasize horizontal production sharing by producing and exporting some of domestic demand and importing the rest, instead of supplying all domestic requirements. It exports various products to Singapore and imports ethylene glycol and polyethylene.

The petrochemical industry in Rep. of Korea saw series of new entrants during the strong growth period after 1988 and its supply-demand balance turned into surplus after 1990, which is mainly exported to China. The rapid increase in production capacity far exceeding the growth of world demand has been affecting the supply-demand balance and price in Asia.

In Taiwan, a construction plan for a new petrochemical plant is delayed due to environmental consideration and difficulty in acquiring land, and imports will be required until the new plant will start commercial operation, slated for 1994.

China has ethylene production capacity of 2.35 million tons and plans to add 1.33 million tons by 1995-96. However, feasible capacity expansion is limited to one half the planned level, namely 670,000 tons. Meanwhile, strong demand for petrochemical products, such as synthetic fibers and their raw materials, is expected to persist, so that volume imports of these products will continue for the time being.

The Middle East countries are major exporters of petrochemical products. Saudi Arabia and Qatar are among the largest, and Iran may join these countries in a few years. At present, Saudi Arabia is expanding its capacity and the total ethylene capacity in the Middle East will reach slightly less 5 million tons by 1996. Exports are mainly bounded for Asian countries, with some going to the U.S. and Europe.

Ethylene production capacities of ASEAN countries are 440,000 tons in Singapore and 320,000 tons in Thailand. By 1995-96, 400,000 tons will be added in Singapore, 450,000 tons in Indonesia, and 230,000 tons in Malaysia, bringing the total capacity to 1,840,000 tons. Meanwhile, demand will reach the same level.

Thus, given the rapid capacity expansion in the neighboring countries, Singapore can no longer rely on volume production of commodity products alone, nor a huge market in China. In fact, the petrochemical industry has already started to explore applications of

currently unused fractions and to expand into high-value products, such as engineering plastics, by shoring up downstream operations.

The petrochemical complex in Singapore ships 300,000 tons of liquid products annually and 500,000 tons of solid products. Liquid products are mostly transported in bulk, using tankers on sea and lorries on road. Oil drums are used for delivery to some of small users. Many of liquid chemicals are designated dangerous. Most of solid products are plastics that are mostly packed in kraft paper bags. Flexible containers are used for some of major customers.

3.3.2.3 Fine chemical industry

Major developments in the fine chemical industry in Singapore are expected to take the form of downstream expansions in the petrochemical sector. In other words, expansion of the petrochemical industry into downstream, high-value areas is likely to take place in the fine chemical segment including pharmaceuticals, cosmetics, soaps and detergents, and paints and dyes, keeping in pace with demand growth in Southeast Asia.

In these areas, fine chemical makers are expected to do more than sales of commodity products. They have to provide technical support for customers; in the case of feedstock sales, technical advice on use as feedstocks, sub-feedstocks or additives, or joint development of feedstocks according to customer specifications; and in the case of final products, customized development of products suitable for specific market conditions. As a result, fine chemical manufacturers are required to have product development and technical support staff.

So far, U.S. and European chemical companies have invested in the fine chemical sector as they start to operate in Singapore. In the future, in addition to additional investment from U.S. and Europe, Japanese manufactures are expected to step up overseas production of fine chemicals, which have traditionally been produced in Japan, while relocating commodity products to overseas.

3.3.2.4 Other chemical industries

Regarding other chemical industries, a titanium oxide plant is only large plant operated in Singapore, and there is no large plant for electrolysis, soda ash, sulfuric acid, fertilizer and similar products. The raw material for titanium oxide – ilmenite ore – seems to be imported in bulk from neighboring countries. Fluid feedstocks and chemical products are shipped in bulk for volume consumption, and in drums, cans, pails or bottles for small use, while solid products are mainly stored in flexible containers or 25kg kraft paper sacks. These chemical products are basically inflammable and dangerous goods.

3.3.3 Current Situation of Packaging and Major Issues

3.3.3.1 Packaging in the chemical and pharmaceutical industries

(1) Role of packaging in the chemical and pharmaceutical industries

In terms of packaging, chemicals and pharmaceuticals can be classified into the following 3 types:

1) Chemicals and pharmaceuticals used as feedstocks or intermediate products for industrial processing

The principal function of packaging for chemicals and pharmaceuticals of this type lies in reduction of transportation cost, improvement of transport efficiency and safety, and preservation chemical properties of contents. These products vary greatly in size from those suitable for small packaging, such as reagents, to those transported in bulk or mass. There are diverse packaging materials and techniques according to the form of chemicals (gas, liquid, solid, or otherwise), the mode of transport, and the unit of handling. Most of them have been field proven, thus presenting few problems.

Many of these chemicals and pharmaceuticals are detrimental, poisonous and/or inflammable, requiring clear and visible instructions on transport, storage, use, and handling, or requiring specific safety measures according to the type of packaging. As a result, these products are often subject to governmental regulations and mandatory standards, necessitating special considerations in packaging design and management.

2) Pharmaceuticals

According to the form of preparation, pharmaceuticals are classified into solid, including powder, granule, capsule, pill, and tablet; semi-solid including ointment, cream, and paste; and liquid such as injectable solution and suspension. These pharmaceutical preparations are developed and manufactured in such a manner to maximize the pharmacologic effect on patients, while minimizing deterioration of the pharmacologic effect over time and ensuring convenience for use. Notably, pharmaceuticals require longer guarantee period than foodstuff, an average of 2 years with more than 3 years in some cases. To maintain the required quality during the period under various physical, chemical, and biological disturbances, packaging technology plays a critical role in addition to preparation technology.

The primary purpose of packaging for pharmaceuticals is to maintain the quality of its contents, i.e., to prevent pharmaceutical products from deteriorating in terms of pharmacologic effect and other quality requirements. For this purpose, physical,

chemical and biological functional properties of the packaging need to be considered from view point of protection, storage, and sealing from outside environment to keep products in the containers directly.

The second function of packaging is found in its design and appearance. Unlike other consumer products, package design for pharmaceuticals should appeal only reliability and cleanliness of product brands. Also, information indicated on the package should conform to requirements set forth in the relevant laws and regulations, according to the type of product, namely prescription drugs or OTC (over-the-counter) drugs. The package for the former is required to clearly indicate the drug name, direction for use, and dosage in order to prevent the misuse at hospitals and pharmacies. On the other hand, the package for the latter is expected to indicate instructions to prevent the misuse by ordinary people, while having a certain degree of visual attractiveness appealing to consumers.

Thirdly, the package should be able to protect its contents from being damaged or contaminated due to aging, compression, vibration, and/or impact in the process of transportation and handling.

Finally, the package needs to be designed to ensure convenience for use by consumers and efficiency in production at the same time; while the ease of intake and portability should be taken into account, the efficiency of packaging, in particular adaptability to automatic packaging, should be maintained.

As discussed later, pharmaceuticals are subject to strict legal requirements under a special law. Although the scope and degree of regulatory control vary from one country to another, it is important for package designers and packaging engineers to become acquainted with legal requirements and standards of a country or area where their products are marketed.

3) Cosmetics and toiletries

Cosmetics and toiletries are directly applied to human skins and therefore should be manufactured without organic and inorganic matters harmful to human body. Because of relatively a high risk of damaging human body, cosmetics and toiletries are subject to strict regulatory control, similar to drugs, in some countries.

At the same time, cosmetics and toiletries are consumer products whose sales are largely affected by individual taste, and container and packaging designs, together with product quality, smell, and feeling of use, are critical factors in appealing to consumers.

(2) Legal regulation related to packaging for chemicals and pharmaceuticals

As mentioned earlier, packaging for chemical and pharmaceutical products is subject to regulatory control and restriction in various aspects.

1) Safety and disaster prevention requirements related to the chemical industry

Principal elements of regulatory control and restriction imposed on the chemical industry are related to safety and disaster prevention. The regulatory control and restriction are mainly enforced for the concerns with 1) prevention of fire, 2) transportation of dangerous goods, 3) handling of control poisons and other harmful materials, and 4) handling of control to high pressure gas.

For the purpose of fire prevention, Japan classifies dangerous goods to the following categories under the Fire Services Act to regulate their production, storage, transport, transfer, handling (loading/unloading, sales). Thus the design and production of the package for chemical products subject to such regulation should satisfy requirements prescribed for each item.

a) Oxidative solids
b) Inflammable solids
c) Hypergolic or antiposic substances
d) Flammable liquids
e) Self-reactive substances
f) Oxidative liquids

Regarding transportation of dangerous goods, specific standards are established for each mode of transport, i.e., land, sea, and air. In particular, for ocean and air transport which is often carried out over international borders, the following international regulations have been introduced for unified control.

a) Ocean transport

i) Individual transport

- IMDG Code (International Maritime Dangerous Goods Code): Unified standards for safety of maritime transport set forth by International Maritime Organization (IMO)
- Container testing and UN marking scheme: Enforced internationally since January 1991.
- Appendix to MARPOL Treaty: Restriction on individual transport of ocean contaminating substances

ii) Bulk transport

The following regulations are applicable to bulk transport of dangerous goods by using a chemical tanker or LPG carrier:

- Appendix to MARPOL Treaty: Restriction on bulk transport of harmful liquid substances
- SOLAS Treaty
- IBC Code: International gas carrier code established by IMO

b) Air transport

- ICAO/IATA: International Air Transport Association (IATA) adopted IATA Dangerous Goods Regulations in 1965, followed by the establishment of the similar regulations by International Civil Aviation Organization (ICAO) under United Nations, and the signing of International Civil Aviation Treaty in 1983. Under the ICAO and IATA regulations, dangerous goods are classified into 9 classes, for each of which requirements related to indication of product name, UN number, class, secondary risk, labeling, grade, and methods of packaging and loading on passenger and other aircraft.

As for poisons and other harmful materials, the Recommendations by the International Expert Committee on Dangerous Goods have set forth standards for carriers.

2) Pharmaceuticals

a) Regulations on packaging

With regard to packaging for pharmaceuticals, regulations are made on containers, sealing, labelling, and so on. The Pharmaceutical Laws in Japan prescribes the following conditions about containers; 1) not to use for other purposes and 2) to protect the contents against alien substances or microbes[16]. As for sealing, the Laws provides that 1) the contents con not be taken out without breaking the seal, and 2) the container can not be returned to the original form once it is opened[17]. The regulations on labelling include 1) indication of poisonous and powerful drugs, 2) specific items to be directly mentioned on the container, 3) exceptions to this rule, and 4) specific items to be mentioned on documents attached.

b) Regulations related to packaging set forth in GMP

Good Manufacturing Practice (GMP) is a general guideline for building advanced production and quality control systems for the purpose of minimizing human error

16) Article 57 of Pharmaceutical Affairs Law and General Rules for Japanese Pharmacopoeia

17) Article 58 of Pharmaceutcal Affairs Law and Article 59 of Enforcement Regulations for Pharmaceutical Affairs Law

and accidental contamination in the pharmaceutical production process, and it is generally established by the pharmaceutical industry and a responsible regulatory organization. Many countries are using GMP to encourage their pharmaceutical industry to introduce advanced production techniques and practices. Regarding the control of packaging materials, GMP regulates it from viewpoints of both production management and quality control.

3) Cosmetics

As pointed out earlier, legal regulation on the packaging for cosmetics varies between countries. Under the Drug, Cosmetics and Medical Instruments Act of Japan, for instance, even itemized cosmetics require approval of the competent minister for each manufacturing facility. In addition, the manufacturer is required to indicate specific instructions and other information on package. Excess packaging is also prohibited under Fair Competition Rules related to indication on cosmetics.

(3) Types of packaging for chemicals and pharmaceuticals, and packaging materials

1) Type of content

Chemicals and pharmaceuticals contained in package are classified according to their form, including solid, powder, stick, liquid, and gas.

2) Ordinary packaging materials and containers for transport

a) Paper bags

Most widely used are unbleached kraft paper sacks and bleached kraft paper sacks, usually consisting of 2 – 4 layered kraft or dump-proofed paper (e.g., laminated paper). Ordinary content weight ranges from 25kg, 30kg to 50kg. Kraft paper sacks are machine-stitched, pasted (between upper and lower edges or bottom part), and bottom folded/pasted.

b) Plastic film bags

Including single-layer film bags made of polyethylene, polyvinyl chloride, polypropylene, and nylon, and multi-layer film bags.

c) Cloth bags

Usually made of natural fibers (mainly vegetable fibers), such as cotton and hemp bags (e.g., burlap bags or Hessian cloth bags made of jute) with content weight between 50kg and 100kg. Also used are cloth bags weaving synthetic fibers such as polyester, vinylon, and nylon, and yarn cloth bags weaving polyolefin stretched tape yarns.

d) Flexible containers

A flexible container is made up of a flexible material to allow the container to be folded in transportation of non-dangerous granular form. It takes the form of bag or sack, with a straps for hoisting and an opening for charge and discharge of cargo. Flexible containers are classified into two types; returnable (designed to be re-usable repeatedly over a long period of time) and one-way (disposable after a single use) with standard content weight of 1 ton.

e) Corrugated board boxes

Corrugated boards are classified according type of flute, to A, B, C, and AB, and the construction, single wall, double wall, or triple wall. Content weight includes 15kg, 20kg, 25kg, 30kg and 50kg.

f) Drums

Usually made of steel, stainless steel, aluminum, galvanized steel and used for 220 liters, 250 1iters, 110 liters or less.

g) Square cans (gallon cans)

Mainly for 18 to 20 liters, made of tin-free steel (TFS) which is made by chemically possivated steel plate, chrome-coated steel or aluminum-coated steel.

h) Metal containers

Mainly for 11 liters.

i) Steel sheet pale cans

Mainly for 20 liters.

j) Oil cans

Same as square cans for 18 liters. 10kg-15kg cans are also available.

k) High pressure gas containers

Usually for 50kg, and 10kg-1,000kg containers are also available. They are often regulated by the law related to handling of high pressure gas.

l) Glass containers

Including heat-resistance glass bottles, acid-resistance glass bottles, and colored bottles, with storage capacity between 500ml and 2l, and content weight of 25kg. Ceramic containers (bottles) are also available.

m) Wooden boxes

Wooden boxes for export packing are classified into the nailed wood boxes and that with skids, and outside plate is sealed or windowed in both types. Content weight ranges from 15kg to 50kg.

3) Plastic materials for packaging of chemicals and pharmaceuticals

Packaging materials for chemicals and pharmaceuticals are mainly made of the above materials and containers, which are often used in combination with plastics. Plastic materials are of thermoplastic made through primary processing of plastic materials (resin) to make a film, which is further formed into molded containers or flexible packaging materials. Films are divided into extrusion and inflation types and are used for internal packages and laminating materials. In addition to single use, films are combined with other resins to make a multi-layer film to improve resistances against heat, chemicals, organic solvents, and/or hydraulic pressure.

Generally, thermoplastic materials with good extruding performance, such as polyethylene, polypropylene, nylon (polyamide), polyvinylidene chloride, polyester, and polystyrene, are widely used. Also used are resins with good chemical-resistance such as phenol, polyether chloride, and Freon resin. Thermoplastics are molded by using various methods, including 1) extrusion molding method, 2) flow molding method, 3) compression molding, and 4) vacuum molding method. The extrusion molding method is most widely used and can be divided into the following types.

a) Inflation method

The method is capable of producing single- or multi-layered films combining properties of different types of resins (strength, resistance to chemicals, and resistance to greases and oils) by using an extrusion molding machine or a combination of two or more machines.

b) T-die method

The method also produces single- or multi-layered films by using an extrusion molding machine or a combination of two or more machines. The method offers better uniformity or stability of film thickness than the inflation method, with the high degree of film transparency. Films and sheets made by the method are molded into blister package materials by using the vacuum molding method or are made to plastic corrugated boards which use shock-absorbing sheets (air cap) or corrugated molded sheets as the core, with flat sheets being adhered to both sides.

c) Blow molding method

Many of packaging bottles and molded containers are made by this method. Containers made by the blow molding method are divided into a single-resin type (including homo-polymer, co-polymer, and polymer blend) and a multi-layered type. Multi-layered containers are used as automotive gasoline tanks with storage capacity of 50 to 100 liters, using a nylon layer as the core that is lined with high density polyethylene on both sides. Single-resin type containers include three-layer co-

extruded bottles using a recycled resin as the core. Thus, the blow molding method is widely used to produce multi-layered containers.

(4) Packaging and physical distribution

Packaging is one of important elements in streamlining a physical distribution system. In this sense, packages need to be designed in consideration to ongoing changes in the physical distribution system. Within the physical distribution system, packaging is closely associated with materials handling including transportation. Major developments in this area can be summarized as follows.

1) Unit loading

Unit loading is an integrated and mechanized transportation and materials handling system, designed to improve the efficiencies of materials handling and transportation, to prevent damage and loss of goods to be transported, and to minimize the packaging cost. One of commercialized systems are an inter-modal system using integrated palletization. A prerequisite to this system is standardization of related packaging and transportation equipment. In Japan, unit load dimensions are standardized in JIS Z0161, dimensions of transportation and packaging systems in JIS Z0105, and flat pallet for through transit in JIS Z0601. Also, container dimensions are regulated by JR Freight Container Standards, JIS Z1610, Large General Freight Container Standards, and International Freight Container Standards.

2) Warehouse automation

Automation of materials handling and transportation at warehouses is being progressed to improve work efficiency. Automated warehouses contain computer-controlled multi-stack racks, with automatic stackers, pallet systems, and automatic sorters being widely introduced.

3) Product coding system and U.P.C. code system

The U.P.C. code is assigned to each package or container and is read by a computer to control flow of goods accurately and efficiently. In the areas of materials handling and transportation, bar codes are used for a variety of jobs including product inspection, inventory control, and sorting. While some countries adopt their own coding system, an increasing number of countries are adopting the international coding system, ITF. Japan originally used the JAN code system as part of JIS, but it adopted ITF codes into the JIS system in 1987. ITF can be used for export approval.

(5) Packaging operation, techniques, and machinery

1) Packaging operation

Packaging operation generally proceeds in the order of measurement and weighing, filling, sealing (closure), and banding or tying. In the measurement and weighing process, contents of each package are weighed, measured in volume, and/or counted. It is directly related to the filling process.

Filling is carried out either by using bags or boxes manufactured in line (for granular or powdery small articles) or by using pre formed bags or boxes manufactured off-line.

Following the filling process, openings of bags or containers are sealed, plugged or capped. Sealing is done by using an adhesive, heat, sewing or tape. Thermal adhesion is done by using electricity, radio frequency wave or ultrasonic.

Finally, corners and exterior of packages are tied up and bundled with steel, plastic, stretch yarn or kraft bands or cords by using a machine. The process often includes machines for indication, marking, printing, and labeling on packages.

Various types of packing machinery have been developed for automation of each of the above processes, as described below.

2) Packaging techniques and machinery

a) Shrink packaging, stretch packaging, and packing machines

Plastic films oriented biaxially without thermo-setting show shrinkability when heated. Shrink packaging uses this property. Stretch packaging, on the other hand, relies on properties of stretch films: 1) flexible and rubber-like elasticity, and 2) extensibility with large stability to produce (i) adherence, and (ii) tying stability. For transportation packaging, these techniques are used to collect and fix contents on pallet, called pallet shrink packaging or pallet stretch packaging. Resins used for these films are polyolefin, polyvinyl chloride, polystyrene, polyester, and EVOH. Packaging machines used for these techniques are a shrink tunnel and hot air generator for shrink packaging, and a rotary stretch packaging machine.

b) Vacuum packaging, gas-charging packaging, and packaging machines

Vacuum packaging is designed to preserve, protect and/or securely fix filling contents, and to minimize the packaging size. After the filling process, air in the package is discharged to create the vacuum state (strictly speaking, reduced pressure). MA (gas replacement) packaging uses nitrogen or carbon dioxide gas which fills the package after vacuuming or pressure reduction.

3) Systematization of packaging

Packaging machines and equipment described above are combined for specific purposes, incorporated into the production line for packaged products, or interlocked with various production processes, thereby to form an integrated system.

4) Other

For safe and reliable packaging operation (particularly, packaging of dangerous goods), working environment needs to be controlled and maintained in the following areas:

a) Safety management: Particularly provision of structures related to work safety
b) Disaster and fire prevention: Particularly provision of explosion-proof motors, lightening arresters, discharge of static electricity, detectors and sensors, alarms, fire fighting facilities and equipment, other related machinery, equipment and tools
c) Hygienic control and aseptic environment: Provision of machinery and equipment related to air-conditioning, dust removal, air cleaning, and sterilization

(6) Package design

The most important points in designing transportation packages for chemicals and pharmaceuticals are discussed below. Note that moisture or gas (e.g., oxygen, carbon dioxide, nitrogen) barrier packaging materials and containers are used in any of the cases. Among packaging techniques, moisture-proof packaging design is particularly important.

1) Considerations related to climatic protection

The possible adverse effects of climatic conditions, such as wind, rain, water, seawater, dew, sunlight, and rough weather, on packaged cargoes need to be considered. For this purpose, adequate moisture-proof performances and standards for packaging materials are established, and desiccants are used.

2) Considerations related to temperature and humidity

Provision should be made to deal with extreme environmental conditions, such as high temperature, low temperature, high humidity, and low humidity. Heat-resistant or freeze-resistant packaging materials and/or fire retarding materials are used for this purpose.

3) Considerations related to pest control

To prevent damage by harmful insects, animals and plants, insecticide, moth repellents and deoxidants are used. To protect packaged materials from decaying, deterioration, discoloration, and other damages due to microorganisms, deoxidants,

desiccants, fungicides, vacuum packaging, and inert gas (nitrogen) charging packaging are used.

4) Marking

In particular, care marking on outer surface is important in designing packages for dangerous goods. Care marking is regulated on a country or international basis.

(7) Environmental consideration

In packaging chemicals and pharmaceuticals, the lifestyle assessment of packaging materials is becoming one of important considerations to take into account weight reduction requirements (volume and/or weight, energy saving), recycling, and the ease of treatment and disposal after use, in addition to original functions of packaging such as protectiveness, the ease of distribution, and economy.

Traditionally, major considerations in development of new packaging materials were placed on design to maximize material performance at the time of use, minimization of manufacturing cost, and the ease of use for customers. Today, they are increasingly replaced with an approach taking into consideration an ecological balance. In such approach, packaging materials are selected in overall consideration to energy consumption and recycling of raw materials and substances through the total process of material preparation, manufacturing, use, disposal, and recycling. Ecological--conscious materials developed on the basis of the viewpoint are selected and designed with environmental considerations, including the care not to destruct an ecological system.

3.3.3.2 Current state of packaging in Singapore

(1) Packaged contents

Most of chemicals and pharmaceuticals packaged or re-packaged in Singapore are industrial products used as raw materials or intermediate products. Also, some manufactured products are packaged in Singapore on a contract basis. From the packaging point of view, these chemicals and pharmaceuticals can be classified as follows:

1) Products which are imported as raw materials or intermediate products and are brought to warehouses or factories, or which are shifted from manufacturing plants in Singapore to customers. They are further divided into:
   a) Those with large lot size: Petrochemical products and plastic resins
   b) Those with small lot size: Paints and pigments, industrial gases, precision chemical products, and chemicals

2) Products which are imported or manufactured as final products for consumers. They are further divided into:

a) Those which are packaged for consumers at the time of import or factory shipment: Pharmaceuticals and cosmetics,

b) Those which are imported in a relatively large lot and re-packaged in Singapore for end users: Pharmaceuticals consigned for packaging, and toiletries.

These chemicals and pharmaceuticals take a variety of forms, including solid, powder, liquid, and gas. Also some of them are classified as dangerous goods, poisons, explosives, and/or inflammable materials.

(2) Type of package

Packaging materials are mainly kraft paper sacks, plastic film bags, plastic bottles, oil drums, metal cans, and glass containers. Imported products are packaged by importers, and products packaged in Singapore use packaging materials generally available in the domestic market. No packaging materials originally developed in Singapore are used, because of 1) limited production and distribution requirements in Singapore, 2) either or both of supplier and purchaser of chemicals and pharmaceuticals is a foreign-affiliated company, and package design is done at its parent company.

(3) Existing infrastructure for physical distribution

Singapore is a small island country and its physical distribution system is simple in structure. Air cargoes are imported or exported through Changi International Airport. There are several maritime cargo terminals, of which Tanjong Perger Terminal is mainly used. There is no freight rail service, and the major mode of inland transport is lorry. The government of Singapore has been making heavy investment in construction of road networks; in 1984, the government spent 150 million Singapore dollars for the purpose. As a result, Singapore boasts a well-developed highway network. In the process, the number of industrial vehicles (for transportation of equipment and materials) increased from around 35,000 in 1970 to 120,000 at present.

At the Port of Singapore, around 700 shipping companies are operating and more than 500 ships arrive or leave every day. The container system was introduced in the 1970s and is operated on the basis of knowledge and know-how learned from many industrial countries. Parallel to the progress of containerization, door-to-door transport service was introduced in place of traditional services divided into warehouse, transportation, and other areas. With the new concept of physical distribution control being disseminated on a global basis in the 1980s, Singapore attracted much attention as

its locational advantages including proximity to major markets as well as good transport access in both air and ocean. Various multinational corporations have established distribution facilities, leading to the development of related technologies and modernization of distribution techniques and practices. In particular, the emergence and growth of freight forwarders[18] played a vital role in modernization of physical distribution in Singapore.

There are many foreign freight forwarders operating in Singapore, including those from Japan. Development of freight forwarding service has enabled shippers to enjoy the benefits of the streamlined distribution system, including 1) formation of diverse distribution routes without having own means of transportation, 2) use of related services with benefits of overall cost reduction, and 3) use of door-to-door service. Foreign freight forwarders are strictly regulated in many countries such as China, Rep. of Korea, and Taiwan, where they are operated as representative offices. In Singapore, however, many of them are operated in the form of local subsidiary or joint venture.

Also, the establishment of related facilities is on the rise, including distribution centers and parks, and logistic centers, to accelerate the streamlining of distribution activities in terms of both hardware and software.

It should be noted, however, that the development of physical distribution services and systems is mainly benefiting foreign-affiliated companies and exporters, while local industries are still dependent upon old distribution services and networks. With the difference in the level and quality of distribution service increasingly widened between the two sectors, local companies do not have infrastructure related to business administration and production management, which are essential in introducing the modern distribution techniques and systems.

(4) Package design and cost control

1) Package design

In Singapore, packages for chemicals and pharmaceuticals are mostly designed in exporting countries. There are no packaging materials originally developed in Singapore, and generally available materials are used. As a result, issues related to packaging are basically the same as those seen in industrial countries, and there are no problems peculiar to Singapore.

Some of locally produced packaging materials are not suitable for packaging chemicals and pharmaceuticals due to insufficient quality control in the production

18) Today the term "freight forwarder" is used for a variety of meanings. By broad definition, the freight forwarder is responsible for a whole or part of 1) tansport-related services, including the preparation of shipping documents, 2) intermediary service for shipping contract, and 3) forwarding service.

process, e.g., plastic bottles which use acceptable materials but caps and mouths do not match for closing, and binding bands which can not maintain required strength. Nevertheless, the chemical and pharmaceutical companies have to use currently available packaging materials due to a small lot of order, and the lack of ability to design packages and make necessary improvement according to customer's request.

2) Package cost control

In Singapore, foreign-affiliated companies are mostly promoting distribution management as key strategies for cost reduction and enhanced competitiveness, mainly food processing, electronics/electrical equipment, petrochemical, and textile industries.

Many of chemical and pharmaceutical companies, on the other hand, have not fully introduced the concept of distribution management. As a result, most of distribution systems in the industry are not organized to control physical distribution activities on a company-wide basis; different departments are maintained and operated to handle only a fraction of distribution activities, such as packaging, warehousing, and transportation, without a department which coordinates or supervise the distribution work as a whole. The lack of centralization prevents troubleshooting in a coordinated manner.

At the same time, there are no standard rules for calculating physical distribution costs among companies, and the definition of the distribution cost varies from one company to another. So is the packaging cost as part of the physical distribution cost. The lack of common standards for controlling the physical distribution cost as well as the packaging cost prohibits companies from accurately finding problems and causes when the packaging cost increases without any apparent reason, thus prohibiting them to devise effective cost reduction measures.

3) Packages for dangerous goods

Although SISIR adopts the UN's "Recommendation on Transport of Dangerous Goods (1988)"[19] as its packaging standards for dangerous goods, there are many cases in which dangerous goods are not transported nor packaged in accordance with the recommendation. This is largely because most of imported products are packaged in exporting countries, and Singapore serves as a place for storage or trans-shipment, making companies handing the products little concern about the package. Another factors in impeding dissemination of the UN Recommendation to local companies are:

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19) The recommendation consists of 400 pages, providing detailed regulations for transportation of dangerous goods. Regulations related to packaging are covered in Chapters 9 and 10, including the methods for packaging dangerous goods, package testing methods, and marking.

1) presence of the recommendation is not widely known, 2) there is no testing organization to conduct necessary tests according to the recommendation, and 3) old packaging methods are adopted without much improvement.

4) Moves toward streamlining of physical distribution

a) Adoption of unit load system and pallet standardization

In Singapore, there is not much interest in improvement of transportation packaging because few leakage or damage occurs in the course of domestic transportation, due to 1) relatively short distance of transport, 2) good road conditions, and 3) robustness of packages for chemical products, including plastic bottles, kraft paper sacks, and oil drums. As a result, the use of the modern distribution system, such as the unit load system, does not receive much attention. Although containers and pallets are used, they do not contribute significantly to the streamlining of physical distribution.

Most of pallets are of flat type made of wood only, while some of them are of box type or made of plastics. Singapore has standards for wooden pallets (flat pallets) based on ISO Standards[20], which are not used in many cases. Many companies are using pallets and fork-lifts for materials handling and product storage at factories, but the size and other specifications for pallets differ greatly from one company to another. The electronic/electric products and parts industry, which is most actively promoting integrated palletization, has not made much progress in standardization of pallet sizes. The situation is similar in transportation of cement.

As a result, pallets are not effectively used to benefit the users. Companies which own specially designed pallets for their own products use them effectively for stacking, but less reliable for loading on lorries which bed does not match with the pallets. Companies which do not have their own pallets use pallets of varying size, which do not stack well and may cause load shifting on the way. In practice, however, few problems have occurred because of relatively short distance of transport and good road conditions.

b) Mechanization of materials handling and transportation

In Singapore, fork-lifts and lorries are most widely used for materials handling, while many handling works are done manually, particularly at local companies. Damages to packaged products often occur due to the falling or throwing.

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[20] 1,200 x 1,000, 1,200 x 800, 1,100 x 1,100 1,109 x 1,016

Nevertheless, labor shortages and wage hikes in recent years have prompted companies for mechanization.

c) Assembly of package modules, automation, and labor saving

Assembly of package modules involves standardization of products and packages in consideration to the entire process of materials handling, transportation, and storage, thereby to reduce the distribution cost. In Singapore, there are few cases of using package modules based on proprietary design. Although some of foreign-affiliated companies establish internal standards based on the above concept, these standards are actually borrowed from those specified by their parent companies.

Automation and mechanization of packaging operation is in progress at foreign-affiliated and large companies, while there are few cases at local companies. Most of local companies use manual labor for their packaging operation, which shows many problems related to quality control.

d) Automation and labor saving for warehouses

The warehousing industry in Singapore has a long history and has made little progress in the areas of automation and labor saving. Most of warehouses are of stack type or rack type, and the rack type using pallets is most widely used to reflect the need for storing goods within a designed space. Fork-lifts are used for handling inside the warehouse, with the rest of work being mostly handled manually.

Although the industry lags behind in the modernization process, except for some foreign-affiliated large corporations, its role in the physical distribution system has been rapidly changing in recent years, by shifting from storage and related services to a wide range of distribution services ranging from documentation for distribution services as a whole, to packaging, labeling, and inventory control.

3.3.3.3 Characteristics of packaging for chemicals and pharmaceuticals in Singapore

From the packaging point of view, chemicals and pharmaceuticals distributed in Singapore are characterized as follows:

1) Locally produced products lack variety and their production size is relatively small, excepting petrochemical products.
2) Many imported products are used with package made in exporting countries, and re-filling for domestic consumption, as carried out for some products, is done under instruction from exporting countries.

3) They are mostly industrial products used as raw materials or intermediate goods, difficult to obtain the differentiation effect due to packaging.

In addition, packages for chemicals and pharmaceuticals have been technologically established in most parts, with little need for development of indigenous packaging technology.

Thus, packages for chemicals and pharmaceuticals distributed in Singapore are not much different from those used in other countries.

3.3.3.4 Issues related to packaging in Singapore

Major issues related to packages for chemicals and pharmaceuticals distributed in Singapore are roughly divided into issues on areas related to packaging, those after packaging, including the handling and transportation of packaged products.

(1) Standardization

Standardization in the areas of packaging and transportation contributes greatly to rationalization of both distribution and production processes. In particular, for Singapore which serves as a regional distribution center, such rationalization not only helps existing companies with strengthening their competitiveness, but it is an essential element of the country's industrial development strategy.

In Singapore, there are 7 standards related to packaging, as follows:

1)	Singapore Standard 344-1988	"Specification for Timber Pallets"
2)	Singapore Standard 321-1987	"Specification for Corrugated Fiberboard Containers for General Purpose"
3)	Singapore Standard 323-1987	"Methods of Test for Flexible Plastic Packaging Materials"
4)	Singapore Standard 331-1988	"Plastic Refuse Sacks"
5)	Singapore Standard 336-1989	"Hermetically Sealed Metal Cans for Foods and Drinks"
6)	Singapore Standard CP9-1988	"The Description and Marking of Articles of, or Containing Precious Metal"
7)	UN Recommendation 1988	"Transport of Dangerous Goods"

All these standards excepting 7) are based on BS, while 7) is borrowed from UN Recommendation. Clearly, these standards are not sufficient to promote standardization in Singapore.

Another obstacle to standardization is that these standards are not widely known among the people who involve packaging operation and aspects.

In Japan, materials, shapes, dimensions, and applications of containers, the methods of transportation and related testing, and many other regulations are established in JIS to form a basis of standardization. Also, pallet and container sizes are standardized under JIS to serve as the basis of standardizing the physical distribution system as a whole. For international transportation and distribution, standardization is promoted on the basis of ISO Standards.

(2) Raising awareness of related laws and regulations

Adequate package design requires sufficient knowledge on laws and regulations related to products in question. The packaging personnel is expected to maintain a minimum required copies of laws and regulations directly related to packaging, and other relevant documentation such as the UN Recommendation on Transport of Dangerous Goods, which is known or understood by a limited number of people in Singapore. Although transportation packages for dangerous goods should be designed by packaging experts, actual design is made by personnel in transportation, warehousing and other parts of physical distribution system.

(3) Standardization of the methods for testing transportation packages, and development of the testing organization and system

For Singapore to fulfill its function as a regional distribution center, it is essential to establish an appropriate organization and system for testing transportation packages. Such organization and system require facilities and equipment, and manpower which are capable of evaluating the quality and performance of transportation packages by using the generally accepted (officially accredited) method. For this purpose, 1) standardization of testing methods, and 2) the establishment of an independent testing organization capable of evaluating packages based on testing standards, are called for.

Notably, appropriate testing and evaluation of transportation packages requires series of tests to analyze the effect of packaging. Test items include at least compression, vibration, impact, and drop tests, with additional items varying with types of materials or products to be tested.

In Singapore, the testing of packages is conducted by a material manufacturer or converter which delivers them, while imported packages are tested in exporting countries. However, neither material maker nor converter has sufficient testing facilities and equipment, and limited portions of required tests are conducted at present. Some of large companies have most of testing equipment and conduct relatively a large number

of tests, but they are by no means capable of conducting all the tests as an independent testing organization, on the basis of officially approved standards. On the other hand, some of foreign-affiliated companies conduct their own tests on the basis of national standards applicable to parent companies.

(4) Education of packaging experts

Undoubtedly, the chemical and pharmaceutical industry requires experts who are familiar with packaging techniques and have basic knowledge on packaging for transportation and export. Such experts need to be trained through systematic education covering theories and practices in the entire packaging process, and they can not be produced from learning an unorganized assortment of knowledge and information. The systematic education should typically cover basic knowledge on materials for containers and other types of packages, durable packaging techniques, including vapor-proofing and rust-proofing, packaging and package design techniques for transportation, and testing methods and procedures.

3.4 Other Industries

3.4.1 Current State of Packaging in Other Industries

(1) Toy

Because of relatively high durability requirements, conventional toys, except for relatively fragile ones, are highly resistant to shock, vibration, and other adverse conditions during transportation, and they are rarely subject to serious damages even if their packages are deformed or damaged on appearance. As a result, packages for conventional toys are designed with emphasis on display characteristics at store, workability in the packaging process after manufacturing, compliance with product inspection standards such as the lack of accessories, and cost effectiveness, rather than protectiveness of contents.

Recently, however, an increasing number of toys use electronic parts and components, such as liquid crystal displays, which are often designed to perform precise and sophisticated operations. Accordingly, important requirements for toy packages are being shifted to impact resistance, vibration resistance, and even moisture resistance, necessitating the use of technology for packages of electronic/electric products.

Packaging materials are by no means immune to such changes. Conventional toys use relatively simple materials for primary packaging, such as card board boxes and plastic bags. In contrast, electronic products increasingly use packaging materials which have shock resistance or vibration resistance, such as retainer type containers and

components which mold from foamed polystyrene and plastic sheets. In designing these materials, techniques used for packages of lightweight electronic/electric products are fully applicable. At the same time, they are required to satisfy requirements for conventional toy packages, making them distinguished from ordinary packages for electronic/electric products. On appearance, they need to satisfy requirements for store display and consumer appeal, while having cost effectiveness to reflect relatively low sales prices. Also their designs need to take into account the fact that toys are generally produced in a small lot at a shop close to the household industry.

(2) Household merchandise and office supplies

Packages for household merchandise and office supplies are also undergoing various changes as they are increasingly sold at large stores and self-service stores, rather than traditional specialty stores.

The conventional form of sales does not require a primary package, or if any, uses a simple package as a minimum "cover" to prevent smear or damage to the product at the storefront, such as transparent plastic bags or kraft paper sacks. On the other hand, self-service sales require new features which have not previously received much attention, such as suitability for display, consumer appeal to reveal product characteristics, and the ease of use.

Also, new types of display, such as hook display, are used for sales at self-service stores for prevention of theft and the need for inventory management at the storefront, thereby demanding different types of packaging methods and materials. Also, sales management using UPC codes requires a new type of package accommodating printed codes.

The new types of packaging methods and materials include a combination of transparent envelope-type plastic bags with label-pasted paper boards, a combination of blister packs which is thermo-formed from PVC sheets with paper boards, skin packs which stick a product on a paper board with a soft plastic film by using the product as the mold. All of the packages are more expensive than conventional ones.

(3) Garments and clothes

Packages for garments and clothes have been changing with the changes in the form of sales. Today, packages for clothes are increasingly simplified, while requiring transportation packages to function as the primary packaging. During inland transport from a shop to a retail outlet, clothes are generally kept on coat hangers by using locker-type containers made of corrugated fiberboard. In particular, packages for male clothes, such as shirts and jackets, are increasingly packed in simple plastic bags, instead of